

Comment and Response

Comment on “Removal of heavy metals from aqueous solution by carbon nanotubes: adsorption equilibrium and kinetics” by Li, Y.H., Di, Z.C., Luan, Z.K., Ding, J., Zuo, H., Wu, X.Q., Xu, C.L. and Wu, D.H.

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Recently, Li *et al.* (Li, 2004) published the paper entitled as above. In section 2.2: Adsorption kinetics, authors mentioned three kinetic models, the first-order rate equation, pseudo-second-order rate equation, and second-order rate equation citing a secondary reference (Benguella, 2002). However, there are mistakes occurred in this reference (Ho, 2004a).

It is Lagergren (Lagergren, 1898) who first presented the first-order rate equation for the adsorption of oalic acid and malonic acid onto charcoal. Lagergren's kinetics equation has been most widely used for the adsorption of an adsorbate from an aqueous solution. In order to distinguish kinetics equation based on adsorption capacity of solid from concentration of solution, Lagergren's first-order rate equation has been called pseudo-first-order since 1998 (Ho, 1998a; 1998b; 1998c; 1998d). In addition, citation review of Lagergren's kinetic rate equation on adsorption reactions has also been reported (Ho, 2004b).

The second-order kinetic expression for the adsorption systems of divalent metal ions using sphagnum moss peat has been presented by Ho (Ho, 1995). At the same time Ho has presented a definition for the initial adsorption rate from the pseudo-second-order equation. In order to distinguish kinetics equation based on adsorption capacity of solid from concentration of solution, Ho's second-order rate expression has been named pseudo-second-order (Ho, 1998a; 1998b; 1998c; 1998d). The earlier application of the pseudo-second-order equation to the kinetic studies of competitive heavy metal adsorption by sphagnum moss peat was undertaken by Ho *et al.* (Ho, 1996). The modified pseudo-second-order kinetic expression has been reported since 1997 (Ho, 1997) and also been presented in following years (Ho, 1998a; 1998b; 1998c; 1998d). In addition, Azizian (Azizian, 2004) has also presented a theoretical analysis for pseudo-second-order equation. The most frequently cited papers were published in Environmental Technology (Ho, 1996), Process Safety and Environmental Protection (Ho, 1998a; 1998b), Journal of Environmental Sciences and Health Part A—Toxic/Hazardous Substances & Environmental Engineering (Ho, 1999a), Chemical Engineering Journal (Ho, 1998c), Resources, Conservation and Recycling (Ho, 1999b), Process Biochemistry (Ho, 1999c), and Water Research (Ho, 2000). In addition, similar comments have

also been published in Adsorption Science & Technology (Ho, 2002), Journal of Colloid and Interface Science (Ho, 2003a; 2004c; 2004d), Journal of Chemical Technology and Biotechnology (Ho, 2003b), Biochemical Engineering Journal (Ho, 2003c), Bioresource Technology (Ho, 2004e), Environmental Science & Technology (Ho, 2004f), Water Research (Ho, 2004a), and Fresenius Environmental Bulletin (Ho, 2004). The pseudo-second-order rate expression of Ho has been widely applied to the sorption of metal ions, dyes, herbicides, oil and organic substances from aqueous solutions (Ho, 2002; 2003a; 2003b; 2003c; 2004a; 2004c; 2004d; 2004f; 2004).

Research papers conventionally include an introduction, a description of the objectives and procedures of the study, an account of the results and a discussion of the results and their implications. However, a paper's contribution existed not only in its originality and creativity, but also in its continuity and development for the following researches. The reference section can play a key role to researchers that were interested in the paper's statement and would like to follow the study or find useful information from the paper (Ho, 2004b). Calne *et al.* (Calne, 1992) suggested that authors should cite relevant work of others, as well as their own. Authors could merely be instructed to include key citations in their introduction and to verify, in writing, that they have fully reviewed published work. I suggest that Li *et al.* cite Ho's original pseudo-second-order kinetic expression paper and Lagergren's pseudo-first-order kinetic model paper.

References:

- Azizian S, 2004. Kinetic models of sorption: A theoretical analysis[J]. Journal of Colloid and Interface Science, 276: 47—52.
- Benguella B, Benaissa H, 2002. Cadmium removal from aqueous solutions by chitin: Kinetic and equilibrium studies[J]. Water Research, 36: 2463—2474.
- Calne D B, Calne R, 1992. Citation of original research[J]. Lancet, 340: 244.
- Ho Y S, 1995. Ph D. University of Birmingham, Birmingham, U.K.
- Ho Y S, Wase D A J, Forster C F, 1996. Kinetic studies of competitive heavy metal adsorption by sphagnum moss peat[J]. Environmental Technology, 17 (1): 71—77.
- Ho Y S, McKay G, 1997. In: Advances in adsorption separation science and technology (Zhong L., Zhenhua Y ed.)[C]. The proceedings of the fourth China-Japan-USA symposium on advanced adsorption separation science and technology, May 13—16, 1997, Guangzhou, China. Guangzhou: South China University of Technology Press. 257.
- Ho Y S, McKay G, 1998a. A comparison of chemisorption kinetic models applied

- to pollutant removal on various sorbents [C]. *Process Safety and Environmental Protection*, 76B: 332–340.
- Ho Y S, McKay G, 1998b. Kinetic models for the sorption of dye from aqueous solution by wood [C]. *Process Safety and Environmental Protection*, 76B: 183–191.
- Ho Y S, McKay G, 1998c. Sorption of dye from aqueous solution by peat [J]. *Chemical Engineering Journal*, 70: 115–124.
- Ho Y S, McKay G, 1998d. The kinetics of sorption of basic dyes from aqueous solution by sphagnum moss peat [J]. *Canadian Journal of Chemical Engineering*, 76: 822–827.
- Ho Y S, McKay G, 1999a. Comparative sorption kinetic studies of dye and aromatic compounds onto fly ash [J]. *Journal of Environmental Science and Health, Part A—Toxic/Hazardous Substances & Environmental Engineering*, 34: 1179–1204.
- Ho Y S, McKay G, 1999b. A kinetic study of dye sorption by biosorbent waste product pith [J]. *Resources Conservation and Recycling*, 25: 171–193.
- Ho Y S, McKay G, 1999c. Pseudo-second order model for sorption processes [J]. *Process Biochemistry*, 34: 451–465.
- Ho Y S, McKay G, 2000. The kinetics of sorption of divalent metal ions onto sphagnum moss peat [J]. *Water Research*, 34: 735–742.
- Ho Y S, 2002. Comment on “Removal of Ni²⁺ and Cu²⁺ ions from aqueous solutions on to lignite-based carbons”, by S. E. Samra [J]. *Adsorption Science & Technology*, 20: 199–201.
- Ho Y S, 2003a. Comment on “Adsorption of fluoride, phosphate, and arsenate ions on a new type of ion exchange fiber,” by R X Liu, J. L. Guo, and H X Tang [J]. *Journal of Colloid and Interface Science*, 262: 307–308.
- Ho Y S, 2003b. Letter to the editor [J]. *Journal of Chemical Technology and Biotechnology*, 78: 724.
- Ho Y S, 2003c. “Affinity dye-ligand poly(hydroxyethyl methacrylate)/chitosan composite membrane for adsorption lysozyme and kinetic properties” by G. Bayramoglu, M. Yilmaz, M. Y. Arica [J]. *Biochemical Engineering Journal*, 15: 77–78.
- Ho Y S, Bulut Y, Tez Z, 2004. “Removal of heavy metal ions by modified sawdust of walnut” by Bulut, Y, Tez, Z. [J]. *Fresenius Environmental Bulletin*, 13: 370–373.
- Ho Y S, 2004a. Comment on: “Cadmium removal from aqueous solutions by chitin: Kinetic and equilibrium studies” [J]. *Water Research*, 38: 2962–2964.
- Ho Y S, 2004b. Citation review of Lagergren kinetic rate equation on adsorption reactions [J]. *Scientometrics*, 59: 171–177.
- Ho Y S, 2004c. Comment on “An alternative Avrami equation to evaluate kinetic parameters of the interaction of Hg(II) with thin chitosan membranes” by E. C. N. Lopes, F. S. C. dos Anjos, E. F. S. Vieira, and A. R. [J]. *Cestari. Journal of Colloid and Interface Science*, 272: 249–250.
- Ho Y S, 2004d. Comment on “Removal of copper from aqueous solution by aminated and protonated mesoporous aluminas: Kinetics and equilibrium” by Rengaraj, S., Kim, Y., Joo, C. K, Yi, J [J]. *Journal of Colloid and Interface Science*, 276: 255–258.
- Ho Y S, 2004e. “Kinetic modeling and equilibrium studies during cadmium biosorption by dead *Sargassum* sp. biomass” by Cruz, C. C. V., da Costa, A. C. A., Henriques, C. A., Luna, A. S [J]. *Bioresource Technology*, 93: 321–323.
- Ho Y S, 2004f. Comment on “Arsenic removal using mesoporous alumina prepared via a templating method” [J]. *Environmental Science & Technology*, 38: 3214–3215.
- Kapoor A, Viraraghavan T, Cullimore D R, 1999. Removal of heavy metals using the fungus *Aspergillus niger* [J]. *Bioresource Technology*, 70: 95–104.
- Lagergren S, 1898. Zur theorie der sogenannten adsorption gelöster stoffe. *Kungliga Svenska Vetenskapsakademiens* [J]. *Handlingar*, 24: 1–39.
- Li Y H, Di Z C, Luan Z K *et al.*, 2004. Removal of heavy metals from aqueous solution by carbon nanotubes: Adsorption equilibrium and kinetics [J]. *Journal of Environmental Sciences*, 16: 208–211.
- Raji C, Anirudhan T S, 1998. Batch Cr(VI) removal by polyacrylamide-grafted sawdust: Kinetics and thermodynamics [J]. *Water Research*, 32: 3772–3780.
- Zhang L, Zhao L, Yu Y T *et al.*, 1998. Removal of lead from aqueous solution by non-living *Rhizopus nigricans* [J]. *Water Research*, 32: 1437–1444.

Response to comment on “Removal of heavy metals from aqueous solution by carbon nanotubes: adsorption equilibrium and kinetics”

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We would like to thank Dr. Ho for his careful examination of our paper. We agree with the comment on our paper published in *Journal of Environmental Sciences*.

The original first-order rate equation was reported by Lagergren (Lagergren, 1898) and the original pseudo second-order rate equation was reported by Ho *et al.* (Ho, 1996). These equations were cited secondarily in our paper (Li, 2004). We have not obtain the references in the equations and we now acknowledge the value of Dr. Lagergren and Dr. Ho's work.

References:

Ho Y S, Wase D A J, Forster C F, 1996. Kinetic studies of competitive heavy

metal adsorption by sphagnum moss peat [J]. *Environmental Technology*, 17: 71–77.

Lagergren S, 1898. Zur theories der sogenannten adsorption gelöster stoffe. *Kungliga Svenska Vetenskapsakademiens* [J]. *Handlingar*, 24: 1–39.

Li Y H, Di Z C, Luan Z K *et al.*, 2004. Removal of heavy metals from aqueous solution by carbon nanotubes: adsorption equilibrium and kinetics [J]. *Journal of Environmental Sciences*, 16: 208–211.