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SCIENTIFIC LETTERS

Comment on 'An evaluation of copper biosorption by a brown seaweed under optimized conditions' by Antunes, W.M., Luna, A.S., Henriques, C.A. and da Costa, A.C.A.

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Scientific Letter **Response Letter**

In a recent publication by Antunes et al. (2003), and on section Kinetic modeling, the authors presented a pseudo first-order Lagergren model and a pseudo-second order model to describe the kinetic of copper biosorption by a brown seaweed by using Eqs. (7) to (10) without any citations. In fact, it is Lagergren (1898) who first presented the first order rate equation for the adsorption of ocalic 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 and McKay, 1998b; Ho and McKay, 1998c; Ho and McKay, 1998d; Ho and McKay, 1998e). In addition, citation review of Lagergren kinetic rate equation on adsorption reactions has been presented (Ho, 2004a). The correct reference style citing the original Lagergren's paper was first presented by Ho et al. in 1998. That is 'Lagergren, S. (1898), Zur theorie der sogenannten adsorption gelöster stoffe. *Kungliga Svenska Vetenskapsakademiens. Handlingar*, Band 24, No. 4, 1-39.' Its English translated style is 'Lagergren, S. (1898), About the theory of so-called adsorption of soluble substances. *Kungliga Svenska Vetenskapsakademiens. Handlingar*, Band 24, No. 4, 1-39' and the abbreviation style is 'Lagergren, S. (1898), Zur theorie der sogenannten adsorption gelöster stoffe. *Kungliga Svenska Vetenskapsakademiens. Handlingar*, Band 24, No. 4, 1-39'.

The second-order kinetic expression for the adsorption systems of divalent metal ions using sphagnum moss peat has been reported by Ho (1995). Again to distinguish kinetics equation based on adsorption capacity of solid from concentration of solution, Ho's second-order rate equation has been called pseudo-second order. 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. (1996). The modified model has also been reported in following years. The most cited related papers were published in *Chemical Engineering Journal* (Ho and McKay, 1998a), *Water Research* (Ho and McKay, 2000) *Process Biochemistry* (Ho and McKay, 1999e), and *Process Safety and Environmental Protection* (Ho and McKay, 1998b). In addition, similar cases occurred and has been acknowledge in Adsorption *Science and Technology* (Ho, 2002), *Journal of Colloid and Interface Science* (Ho, 2003b; Ho, 2004b), *Journal of Chemical Technology and Biotechnology* (Ho, 2003c), *Biochemical Engineering Journal* (Ho, 2003a), and *Bioresource Technology* (Ho, 2004c).

The pseudo-second order rate expression of Ho has been applied to the adsorption of metal ions, dyes, organic substances, and oil from aqueous solutions (Table 1). Moreover, discussion of the reaction order has been reported such as the comparison of chemisorption kinetic models (Ho and McKay, 1998e) and pseudo-second order model (Ho and McKay, 1999e). Furthermore, Ho's kinetic expression has also been applied to a multi-stage batch adsorption design (Ho and McKay, 1998f; 1999b) and pseudo-isotherm studies (Ho and Wang, 2004). Numerous applications of Ho's kinetic expression have been reported in recent years. A list of pseudo-second order systems is given in Table 1.

A research paper's contribution exists not only in its originality and creativity but also in its continuity and development for research that follows. The reference section can play a key role to researchers who are interested in a paper's statement or who would like to follow the study or find useful information from the paper (Ho, 2004a). I suggest that Ho's original pseudo-second order kinetic expression paper should be cited by Antunes et al. (2003).

Table 1. Pseudo-second order kinetic model of various related systems from the literature.

Sorbent	Sorbate	References
2-Mercaptobenzimidazole–clay	Hg(II)	Manohar et al. 2002
Activated carbon	Hg(II)	Krishnan and Anirudhan, 2002a
Activated carbon	Pb(II), Hg(II), Cd(II), Co(II)	Krishnan and Anirudhan, 2002b
Activated carbon	Cd(II)	Krishnan and Anirudhan, 2003
Activated carbon	Pb(II)	Krishnan et al. 2003
Activated carbon	Cd(II)	Özer and Tümen, 2003
Activated carbon	2,4-dichlorophenoxy-acetic acid (2,4-D)	Aksu and Kabasakal, 2004
Activated carbon	Cd(II), Ni(II)	Basso et al. 2002
Activated clay	Basic Red 18, Acid Blue 9	Ho et al., 2001
Aspergillus niger	Pb(II), Cd(II), Cu(II), Ni(II)	Kapoor et al.1999
Aspergillus niger	Basic Blue 9	Fu and Viraraghavan, 2000
Aspergillus niger	Acid Blue 29	Fu and Viraraghavan, 2001
Aspergillus niger	Congo Red	Fu and Viraraghavan, 2002
Baker's yeast	Cd(II)	Vasudevan et al. 2003
Banana stalk [*Musa paradisiaca*]	Hg(II)	Shibi and Anirudhan, 2002
Base-treated juniper fiber	Cd(II)	Min et al. 2004
Beech leaves	Cd(II)	Ho and McKay, 1999e
Bi2O3	Cr(VI)	Ho and McKay, 1999e
Blast furnace slag, Dust, Sludge, Carbon slurry	Phenols	Jain et al. 2004
Bottom ash	Cu(II) and Pb(II)	Ho and McKay, 1999e
Calcined alunite	Phosphorus	Özacar, 2003
Calcined Mg-Al-CO3 hydrotalcite	Cr(VI)	Lazaridis and Asouhidou, 2003
Chitin, Chitosan, *Rhizopus arrhizus*	Cr(VI), Cu(II)	Sağ and Aktay, 2002
Coir	Cu(II), Pb(II)	Quek et al. 1998a
Coir pith carbon	Congo Red	Namasivayam and Kavitha, 2002
Cypress leaves	Pb(II)	Ho and McKay, 1999e
Diatomaceous clay	Methylene Blue	Shawabkeh and Tutunji, 2003
Fly ash	Omega Chrome Red ME, *o*-cresol, *p*-nitrophenol	Ho and McKay, 1999d
Fly ash	Victoria Blue, OCL, PNP, OCRME	Ho and McKay, 1999e
Grafted silica	Pb(II), Cu(II)	Chiron et al. 2003
Iron oxide-coated sand	As(V), As(III)	Thirunavukkarasu et al. 2003
Microcystis	Ni(II), Cr(VI)	Singh et al. 2001
Microporous titanosilicate ETS-10	Pb(II)	Zhao et al. 2003
Mixed clay/carbon	Acid Blue 9	Ho and Chiang, 2001
Mucor rouxii	Pb(II), Cd(II), Ni(II), Zn(II)	Yan and Viraraghavan, 2003
Myriophyllum spicatum	Pb(II), Zn(II), Cd(II)	Keskinkan et al., 2003

Na-bentonite	Oil	Viraraghavan and Moazed, 2003
Peat	Basic Blue 69, Acid Blue 25	Ho and McKay, 1998c
Peat	Cu(II)	Gündoğan et al., 2004
Peat	Cu(II)	Petroni et al., 2004
Peat	Cu(II)	Ho and McKay, 1999e, Ho and McKay, 2002
Peat	Pb(II)	(Ho and McKay, 1999c)
Peat-resin particle	Basic Magenta, Basic Brilliant Green	Sun and Yang, 2003
Perlite	Cd(II)	Mathialagan and Viraraghavan, 2002
PHC and GAC	Cu(II)	Ho and McKay, 1999e
Phosphate	Pb(II), Cu(II), Zn(II)	Prasad and Saxena, 2004
Pith	Basic Red 22, Acid Red 114	Ho and McKay, 1999a
Pits	Methylene Blue	Banat et al., 2003
Pits	Phenol	Banat et al., 2004
Reed leaves	Cd(II)	Ho and McKay, 1999e
Rhizopus oligosporus	Cu(II)	Beolchini et al., 2003
Sago	Cu(II), Pb(II)	Quek et al., 1998b
Sawdust	Cd(II), Pb(II)	Taty-Costodes et al., 2003
Sawdust	Phenol	Jadhav and Vanjara, 2004
Schizomeris leibleinii	Pb(II)	Özer, 2003
Sepiolite	Acid Red 57, Acid Blue 294	Ozcan et al.,2004
Silicates	Phosphate	Shin et al., 2004
Spent grain	Pb(II), Cd(II)	Low et al., 2000
Sphagnum moss peat	Cu(II), Ni(II)	Ho et al., 1996
Sphagnum moss peat	Chrysoidine (BO2), Astrazon Blue (BB3), Astrazone Blue (BB69)	Ho and McKay, 1998d
Sphagnum moss peat	Cu(II), Ni(II), Pb(II)	Ho and McKay, 2000
Sugar beet pulp	Pb(II), Cu(II), Zn(II), Cd(II), Ni(II)	Reddad et al., 2002
Sugar beet pulp	Pb(II)	Reddad et al., 2004
TNSAC	Phosphate	Ho and McKay, 1999e
Tree fern	Cu(II)	Ho, 2003d
Tree fern	Na(I)	(Ho, 2003e)
Tree fern	Pb(II)	Ho et al., 2004
Vermiculite	Cd(II)	Mathialagan and Viraraghavan, 2003
Waste tyres, Sawdust	Cr(VI)	Hamadi et al., 2001
Wollastonite	Ni(II)	Ho and McKay, 1999e

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