Comment on "Removal of Ni^{2+} and Cu^{2+} Ions from Aqueous Solutions on to Lignite-based Carbons", by S.E. Samra

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Recently, Samra (2000) published the paper entitled as above. In the section on kinetic measurements, Samra mentioned that "Coleman *et al.* (1956) assumed that the adsorption of a divalent metal ion on carbon proceeds via a pseudo-second order mechanism in which adsorption is the rate-limiting step". In fact, Coleman *et al.* (1956) reported the formation constants for Cu^{II}–peat complexes. The peat–Cu^{II} reaction may be written in two ways, in which P refers to the concentration of peat functional groups:

$$2P^{-} + Cu^{2+} \longleftrightarrow CuP_2$$

$$K_c = \frac{[CuP_2]}{[Cu^{2+}][P^{-}]^2}$$

$$2HP + Cu^{2+} \longleftrightarrow CuP_2 + 2H^{+}$$

$$B = \frac{[CuP_2][H^{+}]^2}{[Cu^{2+}][HP]^2}$$

where K_c is a constant for a reaction between a metal ion and charges on a colloidal particle, B is the product of K_c and the ionization constant k_a, and should be independent of the ionic strength.

It is clear that Coleman *et al.* did not assume that the adsorption of a divalent metal ion on carbon proceeds via a pseudo-second order mechanism in which adsorption is the rate-limiting step. However, in 1995, Ho developed a pseudo-second order kinetic expression for sorption systems of divalent metal ions using sphagnum moss peat in which chemical sorption is the rate-limiting step. The initial sorption rate can be evaluated from the pseudo-second order kinetic expression. The initial adsorption rate has also been presented. In addition, the activation energy for sorption can be determined based on the pseudo-second order rate constants using the Arrhenius equation (Ho and McKay 1998a).

The pseudo-second order kinetic expression has been applied to the sorption of lead ions on to peat (Ho and McKay 1998b) and the sorption of lead, copper and nickel ions on to sphagnum moss peat (Ho *et al.* 2000). The pseudo-second order rate expression of Ho has also been applied successfully to sorption systems such as those of basic and acid dyes with peat (Ho and McKay 1998c), wood (Ho and McKay 1998a) and pith (Ho and McKay 1999a). In addition, the Ho kinetic expression has been applied to a multi-metal adsorption system (Ho *et al.* 1996) as well as to the sorption of dye on to sorbent mixture processes (Ho and Chiang 2001). A multi-stage batch sorption design in conjunction with the pseudo-second order kinetic equation has also been reported (Ho and McKay 1998d, 1999c). Numerous applications of the Ho kinetic expression have been reported in recent years. A list of pseudo-second order systems is given in Table 1.

TABLE 1. Pseudo-second Order Kinetic Model for Various Related Systems Quoted in the Literature

Sorbent	Sorbate	Reference
Activated clay	Basic Red 18, Acid Blue 9	Ho *et al.* (2001)
Aspergillus niger	Acid Blue 29	Fu and Viraraghavan (2001)
Aspergillus niger	Basic Blue 9	Fu and Viraraghavan (2000)
Aspergillus niger	Pb^{II}, Cd^{II}, Cu^{II}, Ni^{II}	Kapoor *et al.* (1999)
C. vulgaris	Cd^{II}	Aksu (2001)
Coir	Cu^{II}, Pb^{II}	Quek *et al.* (1998a)
Entrapped *Trametes versicolor* *mycelia*	Cd^{II}	Arica *et al.* (2001)
Fly ash	Omega Chrome Red ME, *o*-cresol, *p*-nitrophenol	Ho and McKay (1999b)
Glass	Cu^{II}	Rappoli and Rowley (2000)
Lignite-based carbons	Cu^{II}, Ni^{II}	Samra (2000)
Microcystis	Ni^{II}, Cr^{VI}	Singh *et al.* (2001)
Mixed clay/carbon	Acid Blue 9	Ho and Chiang (2001)
Peat	Pb^{II}	Ho and McKay (1998b)
Peat	Basic Blue 69, Acid Blue 25	Ho and McKay (1998c)
Pith	Basic Red 22, Acid Red 114	Ho and McKay (1999a)
Rhizopus arrhizus	Remazol Black B	Aksu and Tezer (2000)
Sago	Cu^{II}, Pb^{II}	Quek *et al.* (1998b)
Spent grain	Pb^{II}, Cd^{II}	Low *et al.* (2000)
Sphagnum moss peat	Chrysoidine (BO2), Astrazon Blue (BB3), Astrazon Blue (BB69)	Ho and McKay (1998d)
Sphagnum moss peat	Cu^{II}, Ni^{II}	Ho *et al.* (1996)
Sphagnum moss peat	Cu^{II}, Ni^{II}, Pb^{II}	Ho *et al.* (2000)
Trametes versicolor	Cd^{II}	Arica *et al.* (2001)
Wood	Basic Blue 69, Acid Blue 25	Ho and McKay (1998a)
Zeolite tuff	Pb^{II}	El-Bishtawi and Ali (2001)

It is suggested that Samra should cite the original pseudo-second order kinetic expression and make sure what Coleman *et al.* presented in their paper.

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