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Discussion

A note on the comments by Dr. Y.S. Ho on "Remediation of soil contaminated with the heavy metal (Cd^{2+})"

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Based on the comments by Y.S. Ho [1] on the work of Lin and Lin [2], I would like to address some important issues which are as follows:

The comments by Dr. Y.S. Ho claims to cite the work by Ho [3] for pseudo-second order kinetics expression. I would like to point out that in 1984, Blanchard et al. proposed [4] a second order rate equation for the exchange reaction of divalent metallic ions onto NH_4^+ ions fixed zeolite particles. The linearized form of Blanchard's second order kinetics was given by

$$\frac{1}{q_e - q} - \alpha = kt \tag{1}$$

where q_e represents the amount of dye adsorbed at equilibrium and at any time t and represented in terms of mg/g, k is the second order rate constant. The rate constant can be obtained from the slope of plot between $1/(q_e - q)$ versus time t. Applying boundary conditions $q = 0$ for $t = 0$, it follows that $\alpha = 1/q_e$. Thus this model has an advantage to predict the equilibrium uptake capacity without the support of experimental data. The non-linearized form of Eq. (1) can be given by

$$q = \frac{ktq_e + \alpha q_e - 1}{kt + \alpha} \tag{2}$$

Applying the value of α in Eq. (1) and rearranging, the non-linearized form of pseudo-second order expression can be obtained as follows:

$$q = \frac{q_e^2 kt}{1 + kq_e t} \tag{3}$$

Eq. (3) can be linearized to different types as shown in Table 1. From Table 1, it was observed that the Table 1 can be linearized to atleast four different types: type-1, type-2, type-3 and type-4, respectively. Table also shows the way to obtain the kinetic parameters from these linearized pseudo-second order expressions. Out of the four linearized form of pseudo-second order expression shown in Table 1, type-1 was reported by Ho and McKay in 1998 for the sorption of dye ions onto peat particles. Thus it is evident that pseudo-second order model for solid/liquid adsorption systems is not proposed by Ho and it was only by Blanchard et al. [4] and only a linearized expression was proposed by Ho. Further Blanchard et al.'s and the expression of Ho [3] were proved to be the same for the sorption kinetics of safranin onto rice husk particles [5].

Table 1
Different linearized form of pseudo-second order expression

Type	Linear form	Plot	Parameters
Type-1	$\frac{t}{q} = \frac{1}{kq_e^2} + \frac{1}{q_e}t$	t/q_t vs. t	$q_e = 1/\text{slope}$, $K_2 = \text{slope}^2/\text{intercept}$, $h = 1/\text{intercept}$
Type-2	$\frac{1}{q} = \left(\frac{1}{kq_e^2}\right)\frac{1}{t} + \frac{1}{q_e}$	$1/q_t$ vs. $1/t$	$q_e = 1/\text{intercept}$, $K_2 = \text{intercept}^2/\text{slope}$, $R = 1/\text{slope}$
Type-3	$\frac{1}{t} = \frac{K_2 q_e^2}{q} - \frac{K_2 q_e^2}{q_e}$	$1/t$ vs. $1/q$	$q_e = -\text{slope}/\text{intercept}$, $K_2 = \text{intercept}^2/\text{slope}$, $R = \text{slope}$
Type-4	$\frac{q}{t} = K_2 q_e^2 - \frac{K_2 q_e^2 q}{q_e}$	q/t vs. q	$q_e = -\text{intercept}/\text{slope}$, $K_2 = \text{slope}^2/\text{intercept}$, $R = \text{intercept}$

In addition, the comment [1] mentioned that Lagergen's first-order expression has been called pseudo first-order expression firstly by the Ho and McKay [6]. However Lagergren's first-order rate expression has been expressed as pseudo first-order expression before Ho and McKay's publication [7,8].

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In the adsorption research, Langmuir isotherm [9] have been the most widely used isotherm to represent the adsorption process at equilibrium conditions. In literatures four linearized types of Langmuir isotherm have been reported [10–14]. Irrespective of the linearized expressions reported, it have been widely called as the Langmuir isotherm.

From scientific point of view it is always a must to give credit to the authors who first proposed the theoretical model. Thus I would like to point out that pseudo-second order model was not proposed by Ho, it was originally reported by Blanchard et al. [4]. Thus it will be more appropriate to cite the works by Blanchard et al. [4] for pseudo-second order kinetic expression.

Thus I would like to make a note that the works by Blanchard et al. [4] should be cited for pseudo-second order kinetic expression.

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