Received: 1 February 2016 Accepted article published: 13 April 2016 Published online in Wiley Online Library: 6 May 2016

(wileyonlinelibrary.com) DOI 10.1002/pi.5133

Comments on the paper 'Synthesis and application of ion-imprinted resin based on modified melamine-thiourea for selective removal of Hg(II)'

Yuh-Shan Ho*

Keywords: adsorption; kinetics; pseudo second order model; pseudo-first order model

Recently, Monier *et al.* published the paper entitled 'Synthesis and application of ion-imprinted resin based on modified melamine-thiourea for selective removal of Hg(II)'.[1] In the section Adsorption kinetics, the authors noted: 'For better evaluation of the extraction mechanism and investigation of the rate-limiting step, the obtained kinetic results were treated by using both pseudo-first-order and pseudo-second-order kinetic models, which can be mathematically expressed as follows:

$$\frac{1}{q_t} = \frac{k_1}{q_e t} + \frac{1}{q_e} \quad (9)$$

$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e} t \quad (10)$$

where k_1 and k_2 are the pseudo-first-order rate constant (min^{-1}) and pseudo-second-order rate constant of adsorption ($g\,mg^{-1}\,min^{-1}$) for adsorption, respectively, and q_e and q_t ($mg\,g^{-1}$) are the amounts of metal ion adsorbed at equilibrium and at time t (min), respectively.'

In fact, Eqns (9) and (10) are the same. From Eqns (9) and (10), k_1 can be obtained as

$$k_1 = \frac{1}{k_2 q_e}$$

In addition, the pseudo-first-order model, Eqn (9), is not correct. The units of the parameters in Eqn (9) also cannot agree with each other. Thus means that 'Synthesis and application of ion-imprinted resin based on modified melamine-thiourea for selective removal of Hg(II)' might not be correct. The same mistake has been mass duplicated by Monier *et al.* in *Carbohydrate Polymers*,[2] the *Chemical Engineering Journal*,[3] *Colloids and Surfaces B – Biointerfaces*,[4] the *International Journal of Biological Macromolecules*,[5–8] *Journal of Applied Polymer Science*,[9] *Journal of Colloid and Interface Science*,[10,11] *Journal of Hazardous Materials*,[12–16] *Journal of Molecular Recognition*,[17] *Polymer International*[18] and *Reactive and Functional Polymers*.[19]

In 1898, Lagergren first presented the first-order rate equation for the adsorption of oxalic acid and malonic acid onto charcoal.[20] In order to distinguish the kinetics equation based on concentration of solution and adsorption capacity of solid, Lagergren's first-order rate equation has been called pseudo-first-order since 1998.[21,22] Details of the Lagergren rate equation for adsorption reactions were published in 2004.[23] The most popular form used is

$$\log\left(q_e - q_t\right) = \log\left(q_e\right) - \frac{k}{2.303} t$$

q_e and q_t ($mg\,g^{-1}$) are the adsorption capacities at equilibrium and at time t respectively. k (min^{-1}) is the rate constant of pseudo-first-order adsorption. In recent years, the same mistake has been pointed out in *Food Chemistry*,[24] *Journal of Molecular Liquids*[25] and *Journal of Environmental Sciences – China*.[26]

The pseudo-second-order kinetic expression for the adsorption systems of divalent metal ions using sphagnum moss peat was presented by Ho in 1995[27] and this expression was also published in 1996.[28] A modified equation was presented in 1998 to correct a mistake in the previous paper that was published in 1996.[29,30] The pseudo-second-order kinetic model has a non-linear form

$$q_t = \frac{q_e^2 kt}{1 + q_e kt}$$

and four linear forms:[31]

$$\frac{t}{q_t} = \frac{1}{kq_e^2} + \frac{1}{q_e} t$$

$$\frac{1}{q_t} = \left(\frac{1}{kq_e^2}\right)\frac{1}{t} + \frac{1}{q_e}$$

$$q_t = q_e - \left(\frac{1}{kq_e}\right)\frac{q_t}{t}$$

and

$$\frac{q_t}{t} = kq_e^2 - kq_e q_t$$

The model has been used in numbers of adsorption systems in subsequent years.[32] Furthermore an article entitled

* *Correspondence to: YS Ho, Water Research Centre, Asia University, Taichung, 41354 Taiwan. E-mail: ysho@asia.edu.tw*

Water Research Centre, Asia University, Taichung, 41354, Taiwan

'Pseudo-second-order model for sorption processes' by Ho and McKay[33] has been ranked top in annual citations in the Web of Science category of chemical engineering since 2008.[34] A review of second-order models for adsorption systems gave more details.[35]

In order to stop the proliferation of the mistake of the pseudo-first-order model a comment has been made.[24–26] Citing the original paper not only respects the work of the authors who presented a novel research idea but also discussed this idea in detail in the body of their paper.[36] In my view, Monier *et al.* should have cited the original paper for the pseudo-first-order and pseudo-second-order kinetic models and thereby provided greater accuracy and information details about the kinetic expression they employed.

REFERENCES

1 Monier M, Elsayed NH and Abdel-Latif DA, *Polym Int* **64**:1465–1474 (2015).
2 Monier M, Kenawy IM and Hashem MA, *Carbohyd Polym* **106**:49–59 (2014).
3 Monier M and Abdel-Latif DA, *Chem Eng J* **221**:452–460 (2013).
4 Monier M, Ayad DM and Abdel-Latif DA, *Colloid Surface B* **94**:250–258 (2012).
5 Monier M, Abdel-Latif DA and Mohammed HA, *Int J Biol Macromol* **75**:354–363 (2015).
6 Monier M, Akl MA and Ali WM, *Int J Biol Macromol* **66**:125–134 (2014).
7 Monier M, *Int J Biol Macromol* **50**:773–781 (2012).
8 Bekheit MM, Nawar N, Addison AW, Abdel-Latif DA and Monier M, *Int J Biol Macromol* **48**:558–565 (2011).
9 Monier M, Akl MA and Ali W, *J Appl Polym Sci* **131**:40769 (2014).
10 Monier M, Abdel-Latif DA and Nassef HM, *J Colloid Interf Sci* **445**:371–379 (2015).
11 Monier M and Elsayed NH, *J Colloid Interf Sci* **423**:113–122 (2014).
12 Monier M and Abdel-Latif DA, *J Hazard Mater* **250**:122–130 (2013).
13 Monier M and Abdel-Latif DA, *J Hazard Mater* **209**:240–249 (2012).
14 Monier M, Nawar N and Abdel-Latif DA, *J Hazard Mater* **184**:118–125 (2010).
15 Monier M, Ayad DM, Wei Y and Sarhan AA, *J Hazard Mater* **177**:962–970 (2010).
16 Monier M, Ayad DM and Sarhan AA, *J Hazard Mater* **176**:348–355 (2010).
17 Monier M, Alatawi RAS and Abdel-Latif DA, *J Mol Recognit* **28**:306–315 (2015).
18 Monier M, Elsayed NH and Abdel-Latif DA, *Polym Int* **64**:1465–1474 (2015).
19 Monier M, Ayad DM, Wei Y and Sarhan AA, *React Funct Polym* **70**:257–266 (2010).
20 Lagergren S, *Bihang till Kongliga Svenska Vetenskaps-Akademiens Handlingar* **24**:1–39 (1898).
21 Ho YS and McKay G, *Chem Eng J* **70**:115–124 (1998).
22 Ho YS and McKay G, *Process Saf Environ Protect* **76**:183–191 (1998).
23 Ho YS, *Scientometrics* **59**:171–177 (2004).
24 Ho YS, *Food Chem* **161**:323 (2014).
25 Ho YS, *J Mol Liq* **198**:322 (2014).
26 Ho YS, *J Environ Sci* **26**:2571–2572 (2014).
27 Ho YS, PhD thesis, University of Birmingham, Birmingham, UK (1995).
28 Ho YS, Wase DAJ and Forster CF, *Environ Technol* **17**:71–77 (1996).
29 Ho YS and McKay G, *Chem Eng J* **70**:115–124 (1998).
30 Ho YS and McKay G, *Process Saf Environ Protect* **76**:183–191 (1998).
31 Ho YS, *Water Res* **40**:119–125 (2006).
32 Ho YS, *J Colloid Interface Sci* **283**:274–277 (2005).
33 Ho YS and McKay G, *Process Biochem* **34**:451–465 (1999).
34 Ho YS, *Chin J Chem Eng* **20**:478–488 (2012).
35 Ho YS, *J Hazard Mater* **136**:681–689 (2006).
36 Ho YS, *Adsorpt Sci Technol* **28**:465 (2010).

