A NEW APPLICATION OF MAGNETIC NANOPARTICLE FOR ADSORPTION OF NICKEL (II) METAL IONS FROM AQUEOUS SOLUTION BY BATCH METHOD

LAYTH I. ABD ALI[*1], WAN AINI WAN IBRAHIM[2], AZLI SULAIMAN[3], MOHD MARSIN SANAGI[2,4]

[1,2,3] Separation Science and Technology Group (SepSTec), Department of Chemistry,
Faculty of Science, Universiti Teknologi Malaysia,
81310 UTM Johor Bahru, Johor, Malaysia
[2]Nanotechnology Research Alliance, Universiti Teknologi Malaysia,
81310 UTM Johor Bahru, Johor, Malaysia
[4]Ibnu Sina Institute for Fundamental Science Studies,
Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia
[2]waini@utm.my, wanaini@kimia.fs.utm.my
([1]laitham1977@yahoo.com,[2]waini@utm.my, wanaini@kimia.fs.utm.my,
[3]azli@kimia.fs.utm.my, azli@utm.my, [4]marsin @kimia.fs.utm.my, mmarsin@utm.my)

INTRODUCTION

Ni(II) is toxic for living organism at trace levels. Currently the Environmental Protection Agency (EPA) standard for Ni(II) in drinking water is 0.04 mg/L [1]. The adsorption of metal ions using magnetic nanoparticles is preferred due to their lower costs, have high adsorption capacities, durability and high efficiency, especially for metal ions with trace and ultra-trace concentration level [2]. In this study, an in-house synthesized Fe_3O_4 MNPs adsorbent was evaluated for its feasibility in the adsorption of Ni(II) metal ions from aqueous solutions. Adsorption experiments were investigated by kinetic and isotherm adsorption models.

MAIN RESULTS

The adsorption kinetics is essential for describing the solute uptake rate. Kinetics tests were carried out by adding 60.0 mg of Fe_3O_4 MNPs to 100.0 mL solutions each containing 5.0 and 40.0 mg/L of Ni(II) at pH 6.0, 25ºC with contact time ranging from 30.0 to 360.0 min. Figure 1 shows that the uptake of Ni(II) is quite effective initially, then slows down with lapse of time and reaches equilibrium within 180 min. In order to evaluate adsorption kinetics of Ni(II) onto Fe_3O_4 MNPs, Lagergren pseudo-first order, and H_o McKay pseudo-second order kinetics models were applied to fit the experimental data (Table 1). The adsorption capacities of as-obtained Fe_3O_4 MNPs were examined at pH 6.0, 25ºC with 60.0 mg of Fe_3O_4 MNPs and varied Ni(II) concentrations from 5.0–50.0 mg/L. The adsorption data were analyzed using Langmuir and Freundlich isotherms (Table 2).

1
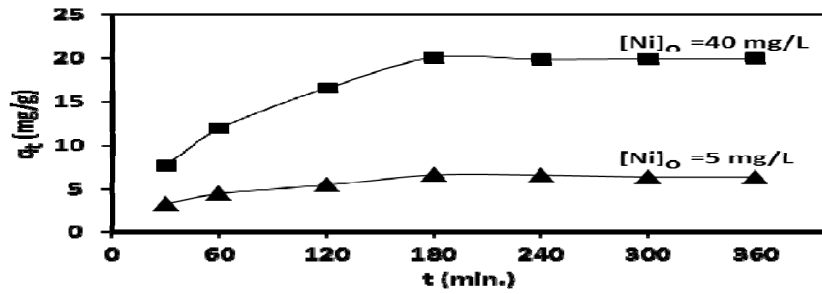
Figure 1. Kinetic data for Ni(II) uptake by as-synthesized Fe_3O_4 MNPs

Table 1: Kinetic parameters of first and second order models fitted to experimental data

Initial Ni(II) conc. (mg/L)	q_e (exp.) (mg/g)	pseudo-first order			pseudo-second order		
		q_e (cal.) (mg/g)	K_1 (min^{-1})	R^2	q_e (cal.) (mg/g)	K_2 (g/mg min)	R^2
5.0	6.58	8.92	0.020	0.9034	7.04	0.004	0.9929
40.0	20.04	17.20	0.014	0.9575	23.47	0.0008	0.9912

Table 2: Isotherm constants for the adsorption of Ni(II) onto as-synthesized Fe_3O_4 MNPs at 25ºC

q_m (exp.) (mg/g)	Langmuir model			Freundlich model		
	q_m (mg/g)	K_L (L/mg)	R^2	n	K_F (L/g)	R^2
20.54	24.57	0.14	0.9973	2.22	4.54	0.9696

REFERENCES

1. Wang, X.S., Huang, J., Hu, H. Q., Wang, J. and Qin Y. Determination of kinetic and equilibrium parameters of the batch adsorption of Ni(II) from aqueous solutions by Na-mordenite. *Journal of Hazardous Materials* 142 (2007), 468–476.

2. Giraldo, L., Erto, A. and Moreno-Piraja´n, J.C. Magnetite nanoparticles for removal of heavy metals from aqueous solutions: synthesis and characterization. *Adsorption* 19 (2013), 465–474.