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EFFECT OF pH ON THE REMOVAL OF Ni (II)

NARENDRA KUMAR PANDEY[*]

Kutir P. G. College, Chakkey, JAUNPUR (U.P.) INDIA

ABSTRACT

In the present study adsorbent such as wallastonite was employed to adsorb the divalent nickel from the industrially polluted water at different pH, 2.0, 5.0 and 9.0. It was found that pH has a significant effect on this adsorption process.

Key words: Divalent nickel, pH, Wallastonite.

INTRODUCTION

Nickel, a metal pollutant is widely used by various modern industries like electroplating, tanning, textiles, etc. resulting in discharge and accumulation in large quantities into the environment. Nickel exists in environment in the form of divalent, which is very toxic. WHO and BIS have recommended the limit value of nickel in drinking water as 0.03 mg/L[3,4]. Adsorption process is one of the leading techniques to remove nickel from waste water. pH has significant effect on the adsorption process.

H^+ ion where as cations are adsorbed preferably at high pH due to accumulation of OH^- ions on the surface. In the present adsorbate-adsorbent system pH affects the nature of the surface charge of the adsorbent. The variation in adsorption of various anionic and cationic species on such adsorbents has been explained on the basis of competitive adsorption or association of potential determining ions i.e., H^+ and OH^- with adsorbate. Tien and Huang have reported a competition between hydrogen and copper ion for the binding sites leading to low copper adsorption on activated sludge at low pH[6]. It is observed that in case of metallic oxides and some other adsorbents the surface adsorbes anion preferably at low pH due to association of study, the influence of pH on the adsorption of Ni(II) on wallastonite from their aqueous solution has been studied in order to find out an appropriate pH range of the maximum efficiency of the removal process[5].

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[*] Author for correspondence; E-mail: drnkpandey562@gmail.com; Ph.: 09451895833, 08756643145

EXPERIMENTAL

Removal and reduction of divalent nickel (II) by the adsorbents have been studied by batch mode[4,6]. These experiments were conducted by first adding appropriate quantities of distilled, deionised water, $NaClO_4$ solution and metal to set of 250 mL polythene bottle by APHA.

Adsorbent wallastonite was then added from the stock solution (20 g/L) which was prepared several weeks prior to all experiments. pH of the solution was adjusted at 2.5. They were shaken in the thermostate at the desired temperature till saturation. At the end of reaction time, the solids were removed by centrifugation and metal concentration Ni(II) of the supernant liquid was determined by means of atomic adsorption spectrophotometer using air-acetylene flames of 429 nm wavelength and slit width of 0.5 mm. Ni(II) concentration was estimated using UV spectrophotometer at 540 nm wavelength by 1,5-diphenylcarbazide method[2,4].

Time-rate adsorption studies were carried out at particular initial concentration and at different pH such as 2.0, 5.0 and 9.0.

Table 1: Time variation for the uptake of Ni(II) by adsorption on wallastonite at different pH

Time (min)	pH-2.0		pH-5.0		pH-9.0	
	Amount adsorbed (mg/g)	% Uptake	Amount adsorbed (mg/g)	% uptake	Amount adsorbed (mg/g)	% uptake
10	0.074	3.0	0.372	15.0	1.753	67.3
20	0.121	5.0	0.712	29.0	1.995	77.1
30	0.136	5.6	0.877	35.5	2.130	82.5
40	0.151	6.2	0.966	38.9	2.237	86.8
50	0.166	6.9	1.036	41.6	2.353	91.4
60	0.176	7.2	1.089	43.7	2.390	92.9
70	0.184	7.5	1.135	45.5	2.447	95.2
80	0.201	8.1	1.169	46.9	2.487	96.2
90	0.218	8.8	1.202	48.5	2.500	97.3
100	0.231	9.5	1.232	49.5	2.529	98.0
110	0.231	9.5	1.232	49.5	2.529	98.0

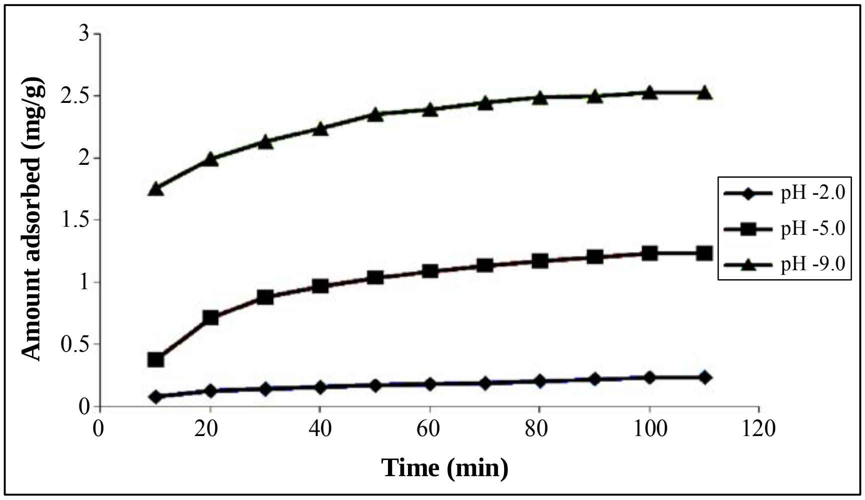

Fig. 1: Effect of pH on the removal of nickel (II) by adsorption process

Table 2: Percentage removal of nickel at different pH

Adsorbate	Adsorbent	pH	% Removal
Nickle	Wallastonite	2.0	09.5
		5.0	49.5
		9.0	98.5

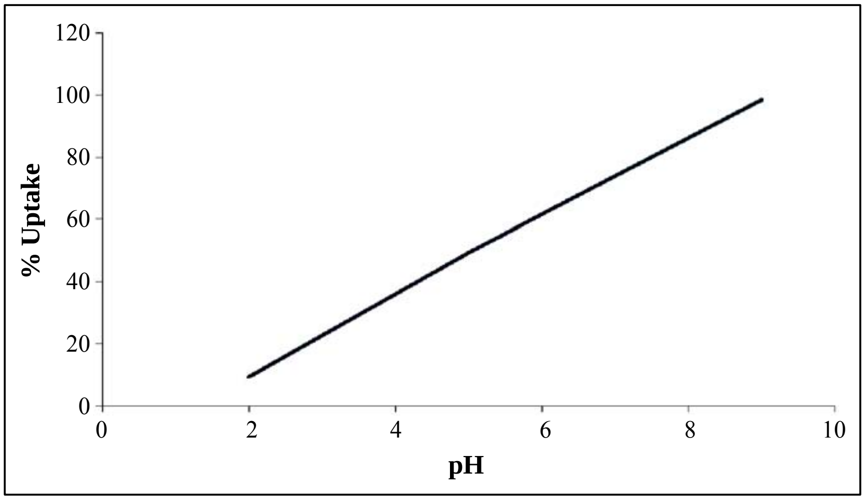

Fig. 2: % Removal of nickel at different pH

RESULTS AND DISCUSSION

It is clear from the table that the pH of the medium has greatly influenced the removal of Ni(II) metal by adsorbent. It shows that the variation in pH does not influence the basic nature of the time-growth adsorption curves or equilibrium period. The adsorption of Ni(II) decrease with the increase in pH of solution. The time-growth plots are initially curved due to rapid removal and in last becomes flat with the lapse of time due to slow removal near saturation. The maximum adsorption of Ni(II) however takes place in the alkaline region. From the above table it shows that the uptake of Ni(II) is higher in alkaline pH up to 5.0, the removal was small and it rises with further increase in pH and goes maximum at pH 9.0. Some workers have reported similar results from the adsorption of Ni on fery hydride. Ni^{2+} is only oxidation states in chemistry of nickel and present as $Ni(H_2O)^{2+}$.[1] The following hydrolysis and adsorption reactions are expected at solid-solution interface.

$$\text{H-OH}^{+} + \text{M}^{2+} \leftrightarrow \text{H-OM}^{(Z-1)+} + \text{H}^{+}$$

$$\text{S-OH} + \text{M}^{Z+} \leftrightarrow \text{S-OM}^{(Z-1)+} + \text{H}^{+}$$

The removal increases between pH 5.0-9.0. The metal competes with protons for surface sites.

$$\text{SOH} + \text{Ni}^{2+} \leftrightarrow \text{S-O-Ni}^{+} + \text{H}^{+}$$

CONCLUSION

From the above investigation made for effect of pH of the uptake of Ni(II), We concluded that at pH 9.0, the maximum removal of Ni(II) was found. pH plays an important role in the anions and cations taken and termed as “master variable” and coulombic attraction. Surface complextion models explain the uptake very much.

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