Using column method for the determination of Ni distribution coefficient

Taherian AM [1], Maleki A[1], Zolghadri S[2], Yousefnia H[2]*, Shiri-Yekta Z[3], Sarfi S[3], Aghayan H[3], Momenzadeh S[1]

[1] Iran radioactive waste management company, P. O. Box: 1439955931, Tehran, Iran.

[2] Radiation Application Research School, Nuclear science and technology Research Institute, P.O.BOX: 14893-836, Tehran, Iran.

[3] Nuclear fuel cycle Research School, Nuclear science and technology Research Institute, P.O.BOX: 14893-836, Tehran, Iran.

* *Email: hyousefnia@aeoi.org.ir*

Abstract

This study was performed to determine the distribution coefficient of nickel on alluvium soil of Anarak nuclear repository by the column method. The effects of different soil heights and concentration of nickel on the distribution coefficient were investigated while the flow rate was considered equal to 1.1 cm^3/min. The nickel distribution coefficient was determined in the range of 0.67-4.30 mL/g with the mean value of 1.85 mL/g. The results indicated inverse correlation between K_d with the contaminant concentration. Moreover, the results confirmed the straightforward relation between K_d and the height of soil column .

Keywords: distribution coefficient, nickel, Anarak, column

Introduction

The distribution coefficient (k_d) is defined as the ratio of the concentration of a substance in one medium or phase to the concentration in a second phase when two concentrations are at equilibrium [1]. K_d plays an important role in the safety assessment of nuclear repositories and indicates the mobility of the radionuclides and heavy metals in the environment [2]. With regard to the high dependency of the k_d to the soil characteristics, EPA strongly suggests the countries use their site specific valuesin the safety assessment [3]. In the assessment of radionuclides activity in various wastes in BNPP, Ni-63 was recognized as one of the present radionuclides with considerable activity. On the other hand, the release of nickel into ecosystems is of great interest because of the observed effects on the human system. As a result, in this research, the authors tried to determine the k_d values of nickel ion for anarak nuclear repositories using the column method.

Experimental

Representative soil of Anarak Nuclear Repository was provided from sampling inside the trench by the channel method. The soil between No. 5 (4 mm) and No. 200 (0.075 mm) stainless steel sieve was utilized in the experiments. A peristaltic pump built by Heidolph (Germany) was employed for the column method while the flow rate was adjusted to 1.1 cm^3/min. The column was filled with different hieghts of soil (3-10 cm). Then, 100 ml of a solution containing nickel contaminant with a certain concentration was added to each column (in order to investigate the effect of concentration, nickel solutions with concentrations of 50, 100 and 200 mg / l were considered). The diagrams of instantaneous concentration to initial concentration were plotted in terms of time. The distribution coefficient was calculated through the delay factor and according to the EPA report [3].

Results and discussion

XRD analysis of Anarak soil was performed while the main minerals of soil were identified as quartz (46%), albite (19%) and calcite (10%), respectively. The distribution coefficient of nickel on anarak nuclear repository was determined in the range of 0.67-4.30 mL/g with the mean value of 1.85 mL/g. The curve of instantaneous concentration to initial concentration versus time for the 50 ppm nickel concentration and the column height of 5 cm is indicated in Figure 1, for instance. The values of k_d for different heights of soil column and contaminant concentration is presented in Figure 2.

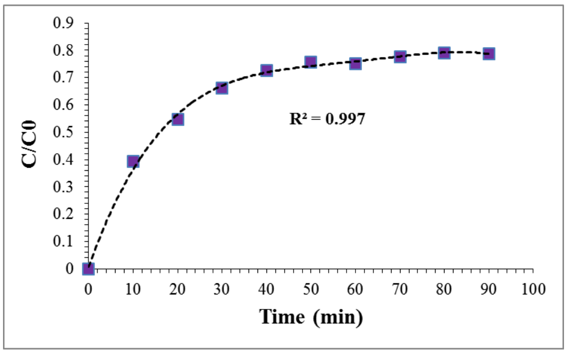

Figure 1. Instantaneous concentration to initial concentration of nickel versus time for the contaminant concentration of 50 ppm and column height of 5 cm.

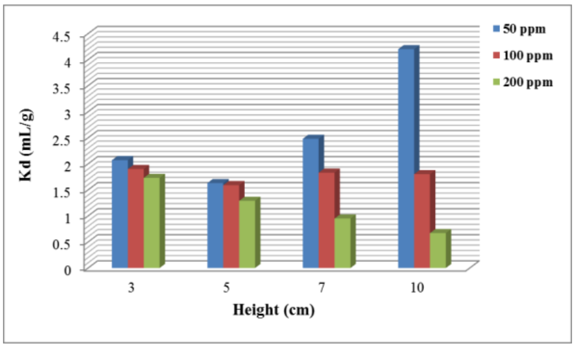

Figure 2. The distribution coefficient of nickel versus the height column for different concentrations.

As can be seen, the distribution coefficient of nickel in the soil decreases with increasing concentration. In fact, as the concentration of ions in solution increases, more ions are provided for adsorption at adsorption sites in the soil, the column is saturated in less time, and the fracture time and distribution coefficient are reduced. Figure 3 shows the distribution coefficients of nickel in terms of concentration for different heights. As can be seen in this figure, the variation of distribution based on the column height do not follow a regular pattern. Although the failure time increases with increasing column height (Figure 4), since this increase is not significant in some cases, with increasing column height, the L / t ratio (contaminant velocity) does not change significantly.

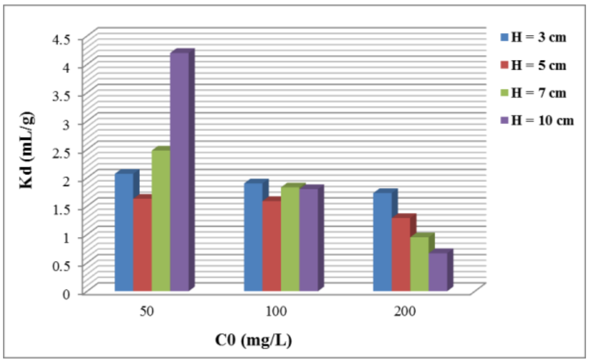

Figure 3. The distribution coefficient of nickel versus contaminant concentration for different column heights.

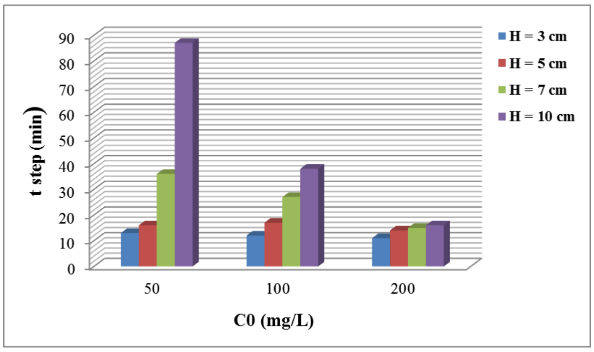

Figure 4. Failure time for nickel based on the contaminant concentration for different column heights.

Conclusions

In this research, the distribution coefficients of nickel on Anarak nuclear repository was calculated for the first time by the column method. The results incated the mean value of 1.85 mL/g . Inverse correlation of kd with contaminant concentration was observed. While the contaminant concentration was considered in the range of 50-200 g/mL, further studies are needed to determine the distribution coefficeint in the lower concentrations of the contaminant.

References

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