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Assessing the environmental pollution of mining and processing plant

It was established that the process of accumulation of heavy metal ions by biological objects can be described by mathematical equations. Application of the received mathematical models gives possible to carry out a prediction regarding the concentration of potential-determining ions, when changing other factors influencing to the process of binding of heavy metal ions by biological objects. Shown that the plants of Chlorophytum type are biosensors that can serve as natural indicators of environmental pollution in industrial areas.

Key words: natural indicators, biosensors, pollution, heavy metal ions, absorption, waste water, mathematical models, plant of Chlorophytum.

Introduction

In mineral processing generate wastes which are suspensions of fine solid particles in water. From the enrichment plant tails direct hydraulic transport in the pond — a complex hydraulic structure, this is an integral part of all mining and processing production. In fact this is a new kind of field — man-made.

The tailings are aggregation of the mining industry waste. The volume of accumulated material in them is estimated in astronomical numbers. They are also the perspective of content and reserves of useful components compared with mining tailing deposits, which are ore-dressing tailings of ferrous and non-ferrous metals. Tails — this is waste of mineral processing, in which the content of a valuable component naturally lower than in the feed, since they are dominated by particles of waste rock. The solid phase of tailings slurry is a mixture of mineral particles of different sizes — from 3 mm to a fraction of a micron. The composition of the particles and their density depends on the mineral composition of the rocks included in the host minerals [1].

The waste of ferruginous quartzite has significant adverse influence on the environment. Transportation of tailings carried by hydro transport with using drainage water. Together with the water in the pond receives various ingredients presented as silicon (63 %), trivalent iron (35 %) and other elements (titanium, manganese, calcium, phosphorus, potassium, etc.) which are amount 2 % [2].

The main sources of environmental pollution by tailings are waste mine dust emissions of heavy metals from the mine, which are tailings of storage tail beneficiation. The soil and vegetation contaminated by gross forms of heavy metals [3].

A significant accumulation of harmful substances in the soil cover leads to lower productivity, a violation of the normal processes of growth and development of crops, poor hygienic quality of the habitat. Possible changes in living organisms, leading to disease. Anthropogenic dust getting into the air during the extraction of ore, blasting operations, drying, sintering ore, quartzite processing by crushing and processing complex, especially when firing pellets at the Pellet Plant, as well as dust blown off the surface of the dumps, dry tailings beaches and hydraulic dump contains increased number of trace heavy metals such as iron, zinc, aluminum, nickel, chromium, copper, lead, manganese, etc. A significant number of pollutants released to the environment from the tailings [4].

Experimental part

Study of the impact of waste water on plants and soil were performed as described [5, 6]. Atomic absorption analysis of samples for metal ions was performed on a grade of AA-140 company «Varian».

Results and discussion

The objects of study were selected plants and soil containing heavy metal ions M^{2+}, where M — Ni^{2+}, Fe^{2+}, Pb^{2+}. To better study of these systems we used the method of mathematical planning, which includes the use matrices (Tables 1–3). The basis of taking was 3-factor 4-tier matrix [7].

Table 1

Scheme of the absorption of heavy metals by root

Water	T_{soil}	τ	C_{met}	Fe_{root}	Pb_{root}	Ni_{root}
				pC		
Waste water (5 day)	–	+	+	1,655	7,240	0,459
Waste water (2 day)	–	–	+	3,96	6,705	0
Waste water (2 day)	+	+	–	1,435	0	0
Water (5 day)	+	–	–	0	0	0

Table 2

Scheme of the absorption of heavy metals by stem

Water	T_{soil}	τ	C_{met}	Fe_{stem}	Pb_{stem}	Ni_{stem}
				pC		
Waste water (2 weeks)	–	+	+	4,867	8,060	0,616
Waste water (2 days)	–	–	+	8,740	6,705	0
Waste water (5 days)	+	+	–	2,976	2,620	2,623
Water (5 day)	+	–	–	0	0	0

Table 3

Scheme of the absorption of heavy metals by soil

Water	T_{soil}	τ	C_{met}	Fe_{soil}	Pb_{soil}	Ni_{soil}
				pC		
Waste water (2 weeks)	–	+	+	0,657	5,160	1,321
Waste water (2 days)	–	–	+	0	0	0
Waste water (5 days)	+	+	–	0	0	0
Water (5 day)	+	–	–	0	0	0

As a variable parameters are defined: the temperature (T) in the range of 278–293 K, the metal concentration (CM) 0.1, and the time (τ) 5 days, 2 days. Mass of soil was 100 g, the flow of solution containing ions of heavy metals to water was 50 ml/day. Composition of test solution after water drainage copper ore is given in Table 4.

Table 4

Composition of test solution after water drainage copper ore

pH	mg/L							
	SO_4	Cl	Mg	Ca	Fe_{sum}	Cu	Zn	H_2SO_4
2,9	5340	350	180	640	406	235	154	123

This solution was used for the evaluation of pollution the soil and plants by iron ions (II) and copper (II). The source of lead and nickel ions served as a solution obtained after the decomposition of iron ore tailings (mine Kentobe) containing 0.652 mg/L of nickel, 2.157 mg/L of lead. As the test plants was used crested plant Chlorophytum (Chlorophytum comosum). Studies have shown that chlorofitum is highly sensitive to water pollution with heavy metals. This differs Bioindicator quick germination of seeds and almost 100 % germination, which significantly reduced in the presence of pollutants. In addition, the roots and stems of Chlorophytum under the influence of pollutants undergo marked morphological changes (stunting and distortion of stems, reducing the length and weight of the roots, the appearance in the leaves of cinnamon-brown spots).

Based on the change in concentration of heavy metals systems were prepared according to each particular factor. Then, using a template, performed for each sample rate factor. The best-known method of finding the optimal parameters — the most of a private function. The processing of the experimental data obtained by the generalized mathematical equation. The resulting mathematical models allow us to find the value of the concentration of heavy metals in all defined terms. Thus, the use of mathematical models makes it possible to carry out prediction of the concentration of potential-determining ions, when the other factors that affect the binding of heavy metal ions of biological objects. Applied mathematical models for the various systems shown below (Table 5).

Table 5

Mathematical models for the various systems M — Ni^{2+}, Fe^{2+}, Pb^{2+}

Object	Function	M^{n+}		
		Ni^{2+}	Fe^{2+}	Pb^{2+}
Root	$C_{M'}=f(T)$	–	$y=1.2\cdot10^{-3}\cdot t-\cdot10^{-2}$	$y=-2\cdot10^{-8}\cdot t+3\cdot10^{-7}$
	$C_{M'}=f(\tau)$	–	$y=9.8\cdot10^{-3}\cdot\tau-1.9\cdot10^{-2}$	$y=-2.33\cdot10^{-8\cdot}\cdot\tau+1,45\cdot10^{-7}$
	$C_{M'}=f(C_M)$	–	$y=-7.2\cdot10^{-3}\cdot C_м+1.8\cdot10^{-2}$	$y=1\cdot10^{-7}\cdot C_м$
Stem	$C_{M'}=f(T)$	$y=-2.0\cdot10^{-2}\cdot t+3.2\cdot10^{-2}$	$y=8,69\cdot10^{-5}\cdot t-8.626\cdot10^{-4}$	$y=1.99\cdot10^{-4}\cdot t-1.99\cdot10^{-3}$
	$C_{M'}=f(\tau)$	$y=4.07\cdot10^{-2}\cdot\tau-8.15\cdot10^{-2}$	$y=1.78\cdot10^{-4}\cdot\tau-3.5\cdot10^{-4}$	$y=3.99\cdot10^{-4}\cdot\tau-7.9\cdot10^{-4}$
	$C_{M'}=f(C_M)$	$y=1.2\cdot10^{-3}\cdot C_м+1.2\cdot10^{-3}$	$y=-5.21\cdot10^{-4}\cdot C_м+5.28\cdot10^{-4}$	$y=-1.199\cdot10^{-3}\cdot C_м+1.19\cdot10^{-3}$

To assess the adequacy of the response function values obtained experimentally and by calculation based on the generalized equations of multiple correlation coefficients were calculated [7], which are presented in Table 6.

Table 6

The correlation coefficients for systems of equations M — Ni^{2+}, Fe^{2+}, Pb^{2+}

Object	Function	M^{n+}					
		Ni^{2+}		Fe^{2+}		Pb^{2+}	
		R	t_R	R	t_R	R	t_R
Root	$C_M=f(T)$	–	–	0.99	8659.82	0.97	59.70
	$C_M=f(\tau)$	–	–	0.94	15.46	0.98	146.35
	$C_M=f(C_M)$	–	–	0.97	59.70	0.99	8659.82
Stem	$C_M=f(T)$	0.99	8659.82	0.99	8659.82	0.99	8659.82
	$C_M=f(\tau)$	0.98	146.35	0.99	8659.82	0.97	59.70
	$C_M=f(C_M)$	0.97	59.70	0.98	146.35	0.98	146.35

By analyzing of obtained results it can be concluded that the using of the developed mathematical models based on probabilistic determined approach is legitimate for these systems. The possibility of using these equations confirmed the values of the correlation coefficient.

Conclusion

Thus, the accumulation of heavy metal ions by biological objects can be described by mathematical equations as confirmed by high values of the correlations. It shows that the plants of Chlorophytum type are biosensors that can serve as natural indicators of environmental pollution in industrial areas.

References

1 *Лотов В.А.* Использование природного и техногенного сырья при производстве строительных материалов и изделий // Проблемы геологии и эксплуатации минеральных ресурсов. — Томск, 2010. — С. 819–820.

2 Методические указания по оценке влияния на окружающую среду размещенных в накопителях производственных отходов, а также складируемых под открытым небом продуктов и материалов. Утв. Минэкобио-ресурсов РК 09.01.95 г. — Алматы, 1995. — 97 с.

3 *Шварцев С.Л.* Гидрохимия зоны гипергенеза. — М.: Недра, 1998. — 366 с.

4 *Панина М.И.* Влияние твердых отходов производства на содержание токсичных компонентов в подземных водах // Ползуновский вестн. — 2009. — № 4. — С. 242–247.

5 *Федорова А.И.* Практикум по экологии и охране окружающей среды. — М.: Владос, 2001. — С. 288.

6 *Лурье Ю.Ю.* Аналитическая химия промышленных сточных вод. — М.: Химия, 1984. — 448 с.

7 *Малышев В.П.* Вероятностно-детерминированное планирование эксперимента. — Алма-Ата: Наука, 1981. — 116 с.

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Қоршаған ортаның тау-кен байыту комбинатының қалдықтарымен экологиялық ластануының жағдайы

Биологиялық объектілерінің ауыр металдар иондарын жинақтау процесі, математикалық теңдеулермен сипатталу мүмкіндігі анықталды. Алынған математикалық модельдерді қолдану, ауыр металдардың иондары биологиялық объектілермен байланысуының процесіне әсер ететін, қалған факторлардың өзгеруі кезінде потенциал анықтағыш ионның концентрациясы жөнінде болжамдарды жүргізуге мүмкіндік береді. Хлорофитум түрдегі өсімдіктер өндірістік аймақтардағы қоршаған ортаның ластануының индикаторы қызметін атқара алады және биосенсорлар болатыны анықталды.

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Оценка экологического загрязнения окружающей среды ГОК

Установлено, что процесс накопления ионов тяжелых металлов биологическими объектами может быть адекватно описан математическими уравнениями. Применение полученных математических моделей даст возможность проводить прогноз относительно концентрации потенциалоопределяющего иона при изменении остальных факторов, влияющих на процесс связывания ионов тяжелых металлов биологическими объектами. Показано, что растения рода хлорофитум являются биосенсорами, которые могут служить естественными индикаторами загрязнений окружающей среды в промышленных районах.

References

1 Lotov V.A. *Problems of Geology and Exploitation of Mineral Resources*, Tomsk, 2010, p. 819–820.

2 *Metodicheskie ukazaniya po ocenke vliyaniya na okruzhayushuyu sredu razmeshennih v nakopitelyah proizvodstvennih othodov, a takzhe skladiruemih pod otkritim nebom produktov i materialov* [*Guidance on environmental impact placed in storage rings industrial waste, as well as the stored outdoor products and materials*], Almaty, 1995, p. 97.

3 Shvarcev S.L. *Gidrohimiya zoni gipergeneza* [*Hydrochemistry supergene zone*], Moscow: Nedra, 1998, p. 366.

4 Panina M.I. *Polzunovsky vestnik* [*Polzunov messenger*], 2009, 4, p. 242–247.

5 Fedorova A.I. *Praktikum po ekologii I ohrane okruzhayushei sredi* [*Workshop on Ecology and protecting environment*], Moscow: Vlados, 2001, p. 288.

6 Lur'ye Yu.Yu. *Analiticheskaya himiya promishlennih stochnih vod* [*Analytical chemistry of industrial wastewater*], Moscow: Khimiya, 1984, p. 448.

7 Malishev V.P. *Veroyatnostno-determinirovannoe planirovanie eksperimenta* [*Probabilistic and deterministic scheduling experiment*], Alma-Ata: Nauka, 1981, 116 p.

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