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Study of Efficiency of Using Inorganic Sorbent in the Recovery of Natural objects Polluted by Heavy Metals

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Mini Review

The development of ferrous and non-ferrous metallurgy in the Urals has led to the pollution of water bodies and soil by sludge and slag waste containing heavy metals. The most polluted territory in the Chelyabinsk region is the Karabash industrial area. Long-term copper smelting production has resulted in water bodies and soil in the area being polluted by copper, zinc, lead, manganese, arsenic, iron, etc. Acid waste water and sludge entering soils and water bodies have caused the death of animals and plants and have made Karabash an ecological disaster area posing a risk to people's health and wellbeing.

We believe that one of the most promising methods of eliminating or reducing the levels of soil and water pollution in the area is the use of sorption technologies. The latest sorption technologies focus on the usage of natural and synthesized materials such as aluminosilicates including clay minerals and zeolites. The sorption ability of these materials is limited by their exchange capacity and sorption reversibility. The practical use of well-known sorbents involves solving certain technological problems, such as "charging" the sorbents with exchange cations, removing the sorbents having reached their maximum exchange capacity from the site and recycling them. This leads to the conclusion that the recovery of large land objects using the abovementioned materials would be technologically difficult and would not be cost-efficient [1-3].

The perfect sorption material for recovering large natural objects should not involve preliminary and periodical chemical preparation of the soil surface and should be environmentally friendly upon retiring. Heavy metal cations absorbed by the material should not be able to return to nature, water or soil. The aim of our research is to study the efficiency of using synthesized inorganic sorbent for soil recovery in the most polluted industrial area of the Chelyabinsk region - the city of Karabash (Figure 1&2).

Figure 1: Polluted soils in the Sak-Elga river high-water bed.

Figure 2: Sludge dumps near a copper smelting plant.

In June 2016 representative soil samples were taken from the Karabash sludge dumps. Our research methods involved determining the soil samples chemical composition using an atomic emission spectrometer “Optima 2100 DV” and controlling the soils hydrogen index. Table 1 contains the chemical composition analysis results of the soil samples taken from the copper smelting plant sludge dump. The data in Table 1 show that the soil samples contain Class 1 hazardous substances in the amounts by far exceeding the corresponding threshold limit values:

Table 1: Soil samples chemical composition.

No.	pH	Al	Ca	Co	Cr	Cu	Fe	K	Mg
1	6,0	61,246	37,185	32	903	86	109,776	2,593	24,078
2	6,2	29,917	52,792	50	77	1741	293,076	3,385	9,235
3	2,4	50,211	136,740	6	111	699	112,890	3,999	10,026
4	2,3	32,056	11,816	32	1,406	946	164,893	2,938	42,196
5	5,0	47,820	22,937	37	658	5319	129,067	3,896	60,039
6	7,0	33,281	112,847	138	456	11266	123,013	3,934	36,281
TLV*mg/kg				5.0	6.0	3.0			
No.		**Mn**	**Ni**	**P**	**Pb**	**Si**	**Ti**	**V**	**Zn**
1		1,239	175	535	1,599	265,906	4,361	750	6,043
2		1,097	121	303	1,603	157,707	1,645	762	27,770
3		699	60	438	969	208,695	2,640	831	2,058
4		661	377	158	765	262,479	2,010	845	920
5		1,233	644	403	1,409	250,160	2,835	863	9,407
6		15,363	838	8,313	6,178	151,716	2,219	1,038	20,453
TLV* mg/kg		1,500.0	4.0		32.0			150.0	23.0

A. Lead -TLV is exceeded 31 to 193 times.

B. Substances of hazard Class 2 and 3 are contained in the following amounts:

C. Cobalt - TLV is exceeded 1.2 to 27.6 times;

D. Chrome- TLV is exceeded 12.8 to 234 times;

E. Copper - TLV is exceeded 28.6 to 3,755 times;

F. Nickel - TLV is exceeded 15 to 209 times;

G. Vanadium- TLV is exceeded 5 to 7 times.

H. Zinc- TLV is exceeded 40 to 1,207 times.

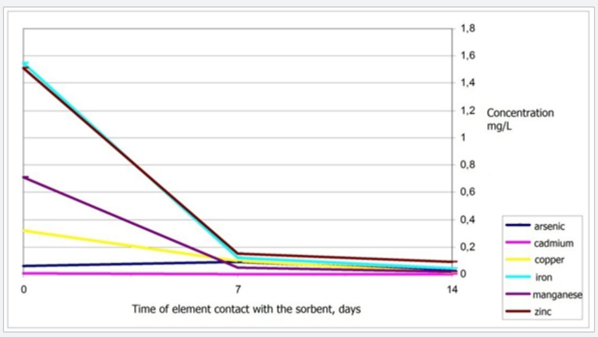

Figure 3: Pollutants concentrations in aqueous extracts taken from soil samples in contact with the sorbent.

The sorption of heavy metal cations from the above soil samples was studied during stationary contact of the soil sample with the sorbent layer in 1:6 ratio by height. At regular intervals, aqueous extract was obtained from the soil samples and its chemical composition was analyzed using the atomic emission spectrometer “Optima 2100 DV”. The experimental data obtained are shown in (Figure 3).

Within 7 days the soil samples were recovered to the chemical composition within the threshold limit values. The experiments carried out modelled a possibility of using the composite sorbent to recover large polluted areas including the possibility of back filling technological reservoirs with the sorbent in order to prevent the migration of pollutants into subsoil waters. The experimental results of the research have proven the efficiency of using synthesized inorganic sorbent in the recovery of the areas polluted by ferrous and non-ferrous metallurgy.

Conclusion

A. A study of heavy metals cations sorption from soils by inorganic sorbent has been carried out.

B. The study has proven the high efficiency of using the sorbent for immobilizing heavy metals cations in the soils of the Karabash industrial area. Within 7 days of static interaction between the soil samples and the sorbent, heavy metals content was reduced to within the threshold limit values.

C. The experimental data have proven the possibility of using the inorganic sorbent efficiently when recovering large natural objects polluted by heavy metals.

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