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Geoecoprotective properties of binders for transport systems

L. B. Svatovskaya[a*], M. V. Shershneva[a], A.B. Bobrovnik[a]

[a] *Emperor Alexander I State Transport University, St. Petersburg, Russia*

Abstract

The article deals with geoecoprotective properties of a sulfatcalcuim system in relation to heavy metal ions. The article presents the research results of determining an optimum contact time of sulfatcalcium products with model solutions. The results of geoecoprotective capacity of sulfatcalcium nature products depend on surface area and weight.

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Keywords: ions, heavy metals, geoecoprotective properties, capacity

1. Introduction

According to the papers [1-3, 24-27] there is a great problem of transport pollution, for example oil pollution, heavy metal ions and others. One of purification ways is to use substances called mineral geoantidotes (MGa) [4-6]. These substances are solid phases. They have ability to absorb water solutions with any natural pollutions due to pores and capillaries. Detoxication of pollutions takes place in pores and capillaries by means of new formation phases [7-9]. New phases have very low solubility product. Reactions in a solid material (stone) are called lithosynthesis [10-12].

As a result of absorption and detoxication processes new phases are geoecologically safe for lithosphere. As mineral geoantidotes binder sulphates can be used. Absorption process begins on the surface of mineral geoantidotes, and the role of a surface is extremely significant [14-15]. In papers [16-18] thermodynamical and physical properties of the surfaces are shown. Milling effects of acid-base ites and some relationships of properties are considered in [19-23]. The main idea of the paper is using calcium sulphate articles for lithosphere detoxication

* L.B.Svatovskaya. Tel.: +7(812) 310-17-25; E-mail address: lbsavatovskaya@yandex.ru

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from some heavy metal ions. The construction function of sulphate calcium hydrate articles is known, and the example of a construction binder system is gypsum. However, geoecoprotective gypsum system properties have not been known before, for example, geoecoprotective property against heavy metal ions. But gypsum stone, or, consequently, gypsum article must have geoecoprotective ability due to pores and capillaries and very low solubility product of some new sulphates. Some sulphate substances $PbSO_4$ and $BaSO_4$ have solubility product 2 · 10-8 and 1 · 10-10, consequently. If gypsum stone has geoecoprotective properties it will be possible to use such construction material for geosphere purification from pollution, for example, from heavy metal ions. Meeting this requirement, new material for transport system protection can be suggested.

2. Method and experiment

Calcium sulphate articles, which by their chemical nature correspond with the formula $CaSO_4 \cdot 2H_2O$, were chosen as mineral geoantidotes (MGa). Gypsum ($CaSO_4 \cdot 2H_2O$) is a binder substance hardening according to reaction 1:

$$CaSO_4 \cdot 1{,}5H_2O + 1{,}5H_2O = CaSO_4 \cdot 2H_2O \quad (1)$$

Gypsum samples were cubed, 2 · 2 · 2 cm, Pb (II) was chosen as a heavy metal ion. Gypsum samples were saturated with solutions of different concentrations Pb (II). After that, absorption level and detoxitation level were calculated. Formulas 1 and 2 were used for calculations. Parameters for the calculation of geoecoprotective properties of articles against heavy metal ions are mentioned in formulas 1 and 2.

$$a_m = \frac{(C_s - C_f) * V_s}{m} \quad (1)$$

$$a_s = \frac{(C_s - C_f) * V_s}{S_s} \quad (2)$$

C_s – start concentration of Pb(II), C_s, model solution, mg/l;
C_f – final concentration Pb(II), C_f, of model solution, mg/l;
a_m – absorptive capacity of article, according to the mass of articles, mg/g;
m – mass of article, g
V_s – model solution volume, l;
S_s - surface area, cm^2;
a_s – absorptive capacity of article, according to the area of articles, mg/cm^2;

Concentrations of the solutions were studied by means of Pb(II)-electrode. Tables 1, 2 and 3 show geoecoprotective properties of gypsum stone in relation to contact time samples and solution with Pb(II)-ions.

Table 1. Purification, %, of solution containing Pb(II)-ions.

Sample number	Mass, m, g	S , cm^2	Final concentration C_f, mg/l	Purification, %
Time of contact is10 minutes; start concentration is 3311,00 mg/l				
1	9,0	23,40	2428,667	26,65
2	8,8	23,60	2496,744	24,59
3	9,0	23,40	2224,97	32,80
4	9,0	23,00	2154,274	34,94
5	9,1	24,00	2324,625	29,79
Time of contact is 20 minutes; start concentration is 2423,00 mg/l				