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New Parameter of Geoecological Protective Ability of Construction Articles

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Abstract. New parameter of geoecological protective ability of construction materials and articles is suggested. Effect is based on the fact that any solid surface possess centers of adsorption. It is shown that Broensted basic surface centers are active in adsorption of heavy metal ions from water solutions and materials having such centers on their surface are able to remove heavy metal ions from water and thus to protect soil from contamination with such ions. For example, foam concrete with ability to adsorb heavy metal ions may be used to protect soil near railway tracks.

1 Introduction

Construction articles should possess such properties as high strength and resistance to low temperatures, low water sorption etc.

In addition to those well-known characteristics we suggest to consider the new one - geoecological protective ability characterizing their ability to adsorb and immobilize heavy metal ions and/or oil products from storm flows, rein waters, waste waters etc. [1-5]. This ability provides detoxication of lithosphere from pollutions which is very important because of modern ecological problems.

In this paper geoecological protective ability of construction articles against heavy metal ions is studied. Important information on such ability is provided by the method of study of surface properties of solids which is called "distribution of active centers" (DAC, [6-12]).

This method provides information about amounts and types of active centers existing on the surface of construction materials including cement based ones.

There are four types of surface active centers: acidic and basic Broensted centers and acidic and basic Lews ones. Particularly Broensted basic centers represent -OH functional groups on the surface.

This groups are capable to interact chemically with heavy metal ions contained in water to form metal hydroxides with very low solubility immobilized on the surface of material [13-16]l.

As a result heavy metal ions are removed from water which was in contact with construction article and thus detoxication effect is achieved.

2 Experiment, results and discussion

For the experiments foam concrete articles were used with average density, D, 0.3; 0.5 and 0.7 ton/m3. Samples were ground up to from particles with diameters d = 0.63...1 mm. [17] Then ground samples were saturated with solutions of heavy metal ions Fe(III) and Mn(II). Such kind of ions occur in water for example as a result of railway transport exploitation therefore there is a need to preserve soil near to railway tracks from contamination with heavy metal ions [18, 19].

After saturation amounts of adsorbed metal ions were measured and adsorption capacities were calculated. Capacity was designated as C, kg/T. Then we suggest to introduce parameter K, reflecting ability of studied construction material to adsorb heavy metal ions and thus its geoecological protective ability, equation (1).

$$K = D \cdot C, \quad (1)$$

Table 1 presents data on several studied cement based materials. According to obtained results, the highest value of geoecological protective ability has material with density value of 0.5 T/m3 and such kind of result is connected with structure of materials and their surface properties [20-22].

Figures 1 and 2 shows distribution of adsorption centers for the studied samples of foam concrete. Distributions show amounts of centers (Y axis) in micromole per kilogram of material depending on pKa value of each center (X axis), pKa being value of negative logarithm of dissociation constant. Centers with pKa values in the range 7...14 represent Broensted basic centers capable to interact with heavy metal ions with formation of metal hydroxides like Fe(OH)3 and Mn(OH)3. From the data of figures 1 and 2 one can see that after the contact with water solutions containing heavy metal ions amounts of Broensted basic centers on the surfaces of studied samples significantly decreased since those centers interacted with ions and thus were blocked by new phases of hydroxides formed on the surface of materials [23].

Thus foam concrete materials may be used in railway construction to protect environment form the pollution with heavy metal ions originated from exploitation of railway transport.

Table 1. Geoecological protective ability of foam concrete materials

Heavy metal ions	Average density of material, T/m^3					
	0.3		0.5		0.7	
	C, kg/T $\cdot 10^3$	K, kg/m^3	C, kg/T $\cdot 10^3$	K, kg/m^3	C, kg/T $\cdot 10^3$	K, kg/m^3
Fe(III)	0.70	0.21	0.5	0.25	0.22	0.15
Mn(II)	2.71	0.81	2.4	1.20	1.50	1.05

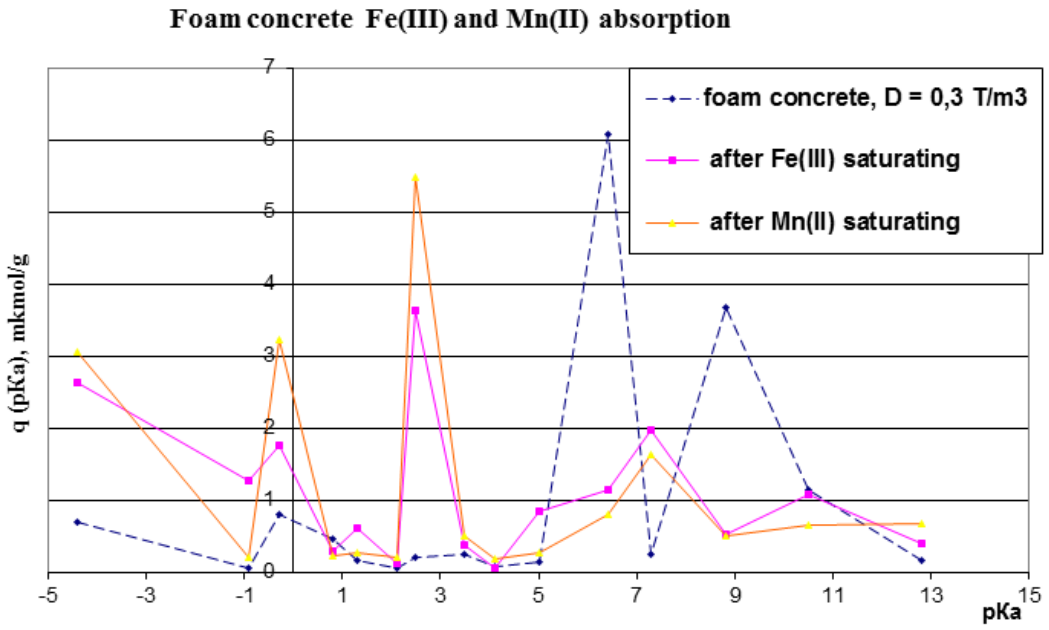

Figure 1. Absorption of heavy ions by foam concrete with density 0.3 T/m^3.

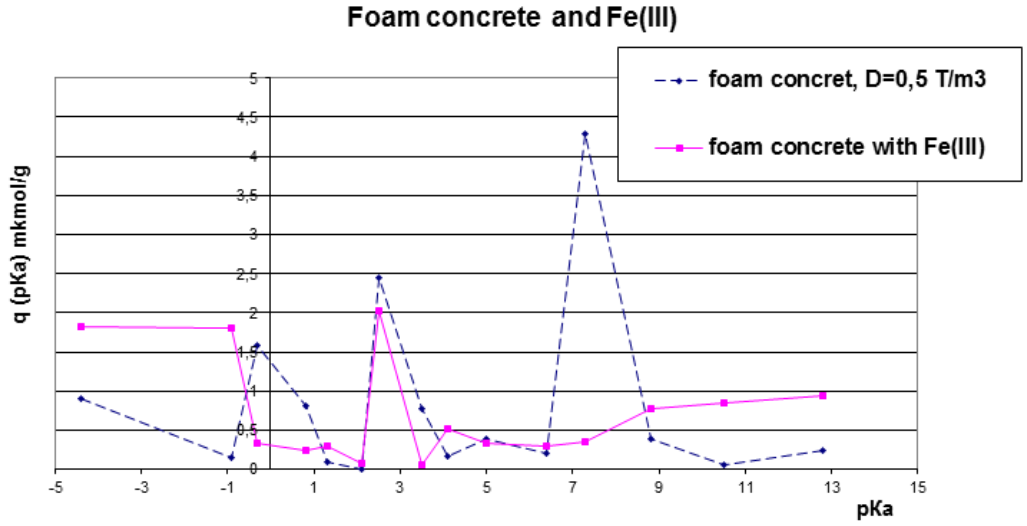

Figure 2. Absorption of heavy ions by foam concrete with density 0.5 T/m^3.

3 Conclusions

The new parameter of geoecological protective ability of construction materials and articles made of them is suggested. Parameter reflects ability of material to adsorb heavy metal ions, oil products and other pollution components. Its value depends on materials density and amount of surface adsorption centers capable to interact with pollutants.

It is shown that foam concrete is able to absorb and remove from the water toxic Fe(III) and Mn(II) ions and thus may be used in railway construction to protect environment form contamination with heavy metal ions originated from exploitation of railway transport.

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