Sorption of Neodymium and Gadolinium on Transcarpathian Clinoptilolite

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Most of the lanthanides (Ln) are closely similar in their chemical properties that causes difficulties in separation and quantitative determination of these elements. In most cases, the quantitative determination methods include the pretreatment procedure of samples such as separation, concentration and removal of rare earth elements (REE). Solid-phase extraction with using different sorbents is one of the way to solve the pretreatment problem of the technological solutions and wastewaters. More often for this purpose are used natural zeolites, which have several advantages in comparison with other sorbents. For example, these natural aluminosilicates have mechanical strength, good stability in aggressive medium and under thermal treatment, ability to sorb the trace amounts of analytes, high sorption capasite and selectivity, possibility of easy modification and regeneration of the sorbent, low cost and accessibility. The sorption properties of the clinoptilolite towards Nd(III) and Gd(III) under dynamic conditions have been studied. Nd and Gd – are of the most popular elements of cerium and yttrium subgroups, respectively. These Ln have been widely used in the electronics, nuclear power, as components of magnetic alloys and phosphors. The zeolite compositions with these REE have the biological activity. The clinoptilolite used in this investigation was obtained from the deposit near the village of Sokirnytsia in Ukrainian Transcarpathian region. The previous analysis has shown that the main component was present at 85-90%, the specific surface area, determined by water sorption was $59\ m^2 \cdot g^{-1}$. The chemical composition of Transcarpathian clinoptilolite is (in %): SiO_2, 67.29; TiO_2, 0.26; Al_2O_3, 12.32; Fe_2O_3, 1.26; FeO, 0.25; MgO, 0.99; CaO, 3.01; Na_2O, 0.66; K_2O, 2.76; H_2O, 10.90. It has been established, that the efficiency of the sorption of Nd(III) and Gd(III) mainly depends on the acidity solutions of Ln and previously thermal treatment of the clinoptilolite samples.

The trace amounts of Nd(III) most effectively sorb on the zeolite from the neutral medium at pH 6.5. However, the best concentration of Gd(III) occurs from the low basic solutions at pH 9,5. Sorption capacity of Transcarpation clinoptilolite towords Nd(III) and Gd(III) ions are 1810 and 6500 μg per 1 g of sorbent, respectively. The trace amounts of Nd(III) mainly exist in the cationic forms of the aqueous complexes $[Nd(H_2O)_9]^{3+}$ in the solutions at pH 6.5. The low basic solutions of Gd(III) have hydroxycomplexes – $[Gd(OH)(H_2O)_7]^{2+}$, $[Gd(OH)_2(H_2O)_6]^{+}$ and $[Gd(OH)_3(H_2O)_5]^{0}$. It has showed, that Nd(III) sorb in general on the clinoptilolite using ion-exchange mechanism. The sorption of Gd(III) on the clinoptilolite takes place by the adsorption of the dissolved hydrolysed forms of Gd(III) on the aluminosilicate surface except the ion-exchange mechanism. The differences on the sorption mechanisms of these Ln give the possibility to separate Nd(III) and Gd(III) in the solutions at pH 9.5. In this optimum condition the clinoptilolite maximum sorbs Gd(III) and practically do not sorbs Nd(III). Despite the sorption capacity of the clinoptilolite depends on the temperature of its previously thermal treatment, Nd(III) most effectively sorbs at the non-roasted clinoptilolite samples. The buffer solutions have been used for maintain of pH, ionic power of the solutions and for the improvements of the metrological characteristics of the preconcentration methods of Ln. In the case of the concentration of Nd(III) the best results have been obtained with thrys-buffer solution. The trace amounts of Gd(III) most effectively sorb with borate buffer solution. The solutions of the mineral acids are the best desorbents of Ln from the clinoptilolite. Because, they provide 100 % removal REE from the zeolite matrix. The influence of the macrocomponents of the water on the sorption of Nd(III) and Gd(III) on the clinoptilolite has been studied. The obtained results showed that Transcarpathian clinoptilolite may be used for removal Nd(III) and Gd(III) from the technological solutions.