roads, football pitch, grass and high vegetation. The numerical studies were performed for the representative rainfall event of H=27.1 mm and 4 h duration and three various types of rainfall distribution, i.e. DVKW, Euler type II and block. The four variants of calculations were considered: i) existing catchment sealing; ii) introduction of green roofs; iii) application of roads and pavement cover by permeable concreate; iv) combined application of green roofs and permeable roads and pavements cover. Numerical calculations covered rainwater outflow as well as total suspended solids (TSS) concentration and load values for the existing sealing types and after application of green roofs and permeable pavements. The obtained results allowed assessment of the environmental impact of LID manners tested.

ADSORBENTS FOR ARSENIC COMPOUNDS REMOVAL

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Arsenic compounds are often observed in natural surface water or groundwater and even in drinking water. It may be possible due to human influence on an ecosystem or as a result of natural, nonanthropogenic processes. Every year a lot of people are affected by toxic action of arsenic compounds [1]. That's why dearsenication is very important in a treatment of arsenic-containing water. Today in the field of water treatment, there are different, competing and effective ways to remove arsenic compounds. These methods include coagulation, anion exchange, reverse osmosis, chemical precipitation (lime softening) and also adsorption [2].

Adsorption is one of the most effective and popular ways of arsenic removal, because it allows the use of reusanable adsorbents. Further to it, adsorbents can be made of recyclable, environmentally safe materials, while the efficiency of the method is not disimproved.

Adsorbents of various origins are used to take the contaminant (arsenic) and include porous materials, both artificial and natural, such as aluminum or silica compounds, activated clays, sawdust, ash, turf, slag etc. Activated carbon of various brands and different fine particle iron-containing adsorbents are likewise effective adsorbents for arsenic removal. It should be notes that activated carbon and iron-containing or aluminum-containing adsorbents are more popular and used for the adsorption of arsenic compounds in addition to other chemicals. Usefulness of this action is determined by a number of factors that must be taken into account by selecting an adsorbent [3,8]. At the start, these reagents must befit a number of criterias, including a low affinity for water molecules and a high interaction with organic compounds, as well as being enough large-porous. High selectivity adsorption capacity is required of adsorbents. The strength and rate of wetting with water are the next significant elements in the adsoption process of arsenic compounds [3].

A magnetite is also used to synthesize adsorbents for arsenic compounds removal. Among other nanomaterials, magnetite nanoparticles offer various benefits. For starters, these nanoparticles have a big surface area, a small border effect and a strong tunnel effect. These effects are very important in the adsorption process. In addition to the natural mineral that can be found, it is possible to produce it in the laboratory from solutions holding ferric and ferrous ions, therefore, they have a strong interconnection for such pollutant as arsenic [4].

The use of nanoparticles and nanostructured materials, which made by magnetite nanoparticles, as efficient and competitive alternatives to conventional adsorbents in the removal of arsenic from water, has recently attracted interest. For instance, the iron-based reagents are used in modern pollutant removal technologies, moreover they have a large surface area and a high surface area to volume ratio owing to their indiscrete size. These properties raise the nanoparticles' adsorption capability, making them potentially appropriate for applications.

Therefore, magnetite nanoparticles (with size about 9 nm) had a high removal rate and a specific adsorption capacity of about 8.25 mg As/g from solution [5]. Because this type of adsorbent has revealed excellent activity in the removal of arsenic compounds, novel adsorbents are developed in the water treatment industry, including granular iron hydroxide, iron-coated sand, iron-based layered double hydroxides, iron-doped activated carbons, zero-valent iron and different modified adsorbents that based on iron oxide. It should be mentioned that, the iron-based adsorbent's sensitivity to pollutant is increased by pH 7 [5].

Fine particle iron oxyhydroxide is also effective adsorbent for removal compounds of As(III) or As(V) [1,2]. According to [2], oxyhydroxide sorption materials obtained by the homogeneous precipitation demonstrate higher sorption activity (up to 70 mg/g for As(III) and over 70 mg/g for As(V)). Activated carbon-based iron-containing sorption materials showed approximately 2 times lower efficiency than powder iron(III) oxide, iron(III) oxyhydroxide and amorphous iron(III) hydroxide.

Activated alumina is another tested adsorbent that can be useful for treatment of arsenic-containing water. According to [5], the adsorption capacity of activated alumina is in the range of 0.003–0.122 g As/g. The ideal pH range for arsenic removal by activated alumina is between 5.5 and 6.0, under these conditions arsenic removal rates is more than 98 % [5].

Nanostructured materials have the potential in water treatment from arsenic compounds. Titanium oxide, mesoporous alumina and other nanocomposites are examples of such nanostructured materials. Adsorbents based on alumina nanoparticles and cryogels, iron oxide and hydrate cerium oxide are very interesting for researchers. Thus, nanoparticles are effective in arsenic compounds removal from water solutions due to its significant specific surface area and high reactivity [6,8].

As part of focus on low-cost adsorbents, scientists research an eco-reagent that can be used as a basis for the production of adsorbents that will clean water from arsenic – red mud. It consists of iron hydroxide and is extracted as a waste product of the alumina production or some other ores processing. Adsorption of arsenic by red mud is a reaction that is based on hydrogen-ion concentration. An acidic solution with a pH range of 1.1 to 3.2 is effectual for extracting As(V), whereas an alkaline condition (pH 9.5) is preferable for removal As(III) [6].

At present, arsenic removal using natural materials or different industrial by-products has provided significant prospects for both economic and environmental positive developments in wastewater treatment procedures. The high cost of some adsorbents and significant regeneration time prevents to use these adsorbents in large scale systems. Scientists develop new adsorbents, which are both highly efficient and low-cost in the pollutant removal processes [7,8].

Consequently, low-cost adsorbents are interesting for many researchers, who are working to improve sorption activity and expand these material application in the removal of pollutants.

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TRANSPORT PROPERTIES OF CERAMIC MEMBRANES BASED ON KAOLIN

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Today, all over the world, membrane water treatment methods no longer raise doubts about their effectiveness and competitiveness. Membrane separation processes are used widely in the petroleum, chemical, pharmaceutical, medical, food, textile, environmental industries, etc [1]. Ceramic membranes are preferred for use in membrane processes because of their high strength, thermal stability, chemical resistance, resistance to abrasive particles, ease of cleaning by backflushing, and long service life. In addition, the use of nanotechnology in the manufacture of ceramic membranes makes it possible to purposefully correct their physicochemical and transport properties [2,3]. Obtaining a material with a defined and controlled pore size makes it possible to predict the selectivity and permeability of the membrane. An analysis of the real operating conditions of membranes and the study of their transport properties under such conditions are very important.

In recent years, due to its low cost, more and more attention has been paid to the production of a matrix of ceramic membranes, the main components of which are such natural minerals as zeolites, clays, apatite, quartz, etc. Clay minerals have high adsorption characteristics and desirable rheological properties. Kaolin, which belongs to clay minerals, is one of the most widespread minerals all over the world, including on the territory of Ukraine.