– реализация бассейнового подхода в работе коллекторов дождевой канализации как основного принципа управления водным хозяйством г. Минска в части отведения поверхностных сточных вод,что позволит уйти от принципа централизации отведения поверхностных сточных вод, в том числе на локальном уровне территорий нового градостроительного освоения;

– создание административной структуры бассейнового управления основныхколлекторов, с целью реализации принципа рационального использования водных ресурсов, целевого распределения материальных ресурсов с персонализацией ответственности за эффективность работы элементов системы дождевой канализации;

– оптимизация водосборных площадей существующих дождевых коллекторов с точки зрения возможности выделения и аккумуляции первой порции дождя (децентрализация системы дождевой канализации, уход от принципа сведения потоков поверхностных сточных вод в один магистральный коллектор). Большие размеры водосборных площадей коллекторов обуславливают усреднение стока по мере поступления его к очистным сооружениям, при этом теряет смысл понятие «первой» порции дождя. Ситуация усугубляется, если учесть мозаичность выпадения дождя по территории города;

– обеспечение систематического контроля за соблюдением промышленными субъектами установленных требований к составу и допустимым концентрациям загрязняющих веществ в сбрасываемых с их территорий в городские сети дождевой канализации г. Минска поверхностных и нормативно чистых (очищенных) производственных сточных водах;

– установление дифференцированного (повышающего) тарифа на услуги канализации при наличии в сбрасываемых поверхностных и нормативно чистых (очищенных) сточных водах загрязняющих веществ, превышающих допустимые концентрации, с целью стимулирования предприятиями рассмотрения вопросов строительства или реконструкции существующих локальных очистных сооружений для достижения более высокой степени очистки поверхностных сточных вод;

– внедрение автоматической системы мониторинга качества поверхностных сточных вод (автоматические датчики контроля) системы дождевой канализации города для усиления ведомственного контроля.

Список использованных источников

1 Дикаревский, В.С. Отведение и очистка поверхностных сточных вод / В.С. Дикаревский. – Л.: Стройиздат, 1986. – 224 с.

2 Алексеев М.И., Курганов А.М. Организация отведения поверхностного (дождевого и талого) с урбанизированных территорий. М.: Изд-во АСВ; СПб.: СПбГАСУ, 2000. 352 с.

3 Чечевичкин В.Н., Ватин Н.И. Особенности состава и очистки поверхностного стока крупных городов // Magazineof. CivilEngineering, No.6, 2014. – Pp. 67-74.

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INFLUENCE OF PREPARATION CONDITIONS ON AS(V) SORPTION EFFICIENCY APPLYING ACTIVATED CARBON DOPED BY IRON OXYHYDROXIDE

1. Introduction and Theoretical Background. Anthropogenic and natural factors often make the surface and ground water sources unfit for drinking purpose therefore it is necessary to clean it. Arsenic belongs to chemical elements, which are often found in natural waters and make it unsuitable for consumption without special treatment [1, 2].

Arsenic is released into water bodies as a result of human activity (arsenic dyes and pigments production, usage of arsenic pesticides, producing of arsenic semiconductors, sulphide ore

production, etc.) and natural processes (leaching from arsenic rocks and minerals, forest fires, volcanic activity) (Figure 1).
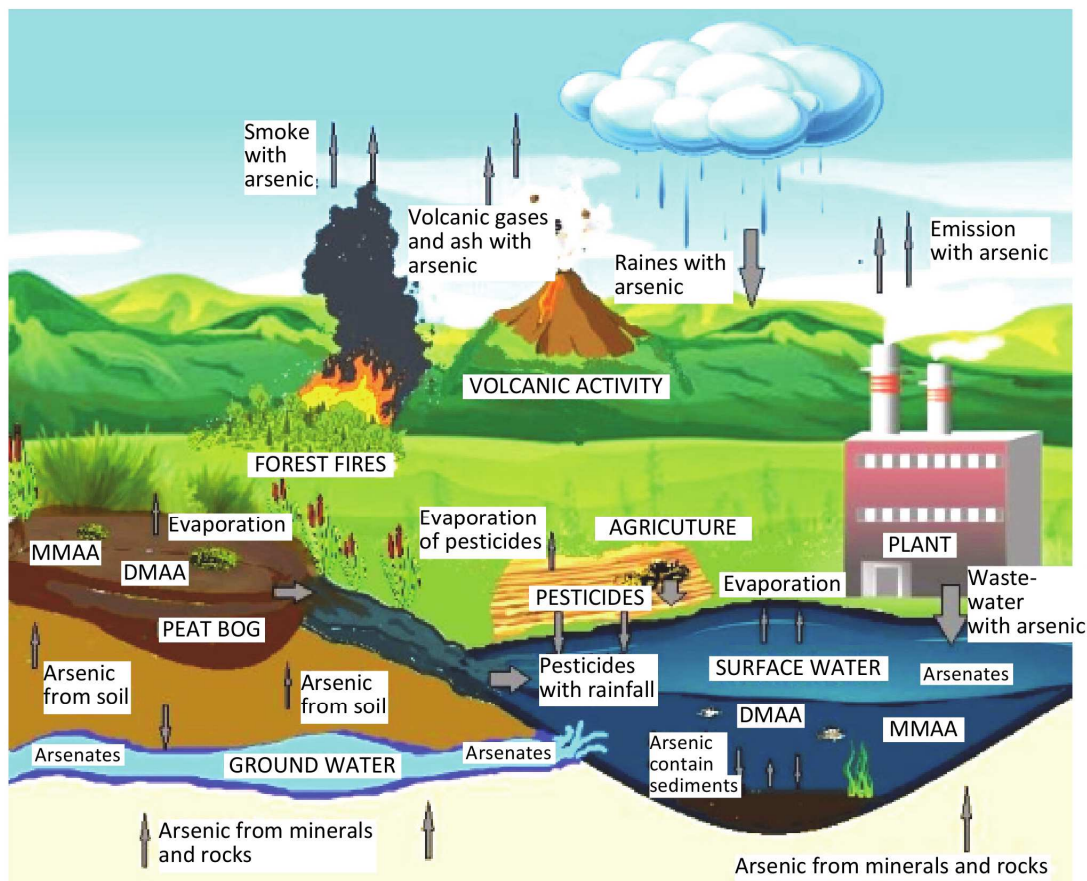
Figure 1 – Sources and pathways of arsenic compounds getting into natural waters

According to the EU Directive the maximum permissible concentration of arsenic in drinking water is 10 µg/l. But in many countries (China, Chile, Malaysia, Taiwan, etc.) arsenic content in natural waters is much higher than this level [1-3].

Long-term consumption of arsenic compounds, contained in drinking water, can cause serious health problems [2, 4].

So, dearsenication is very important stage of the drinking water treatment.

Arsenic compounds can be removed from water by different methods (ion exchange, coagulation, reverse osmosis, adsorption, lime softening, etc.). Adsorption is one of the most popular methods of arsenic removal. As usual sorbents for arsenic removal contain compounds of iron, aluminium or manganese, because these elements can effectively remove arsenic compounds.

Granular adsorbents are more comfortable for usage than powder sorbents due to easier separation from water. But poorly soluble arsenates of iron, aluminium or manganese can block the reaction surface and adsorption material inside the granules can not be used. So, cheap and highly porous carrier, for example activated carbons, can be good solution of these problems.

2. Materials and Methods. Four adsorbents were used to determine the influence of preparation conditions on As(V) sorption efficiency applying activated carbon doped by iron oxyhydroxide:

– birch activated carbon (Sorbent 1);

– birch activated carbon doped by iron oxyhydroxide (Sorbent 2);

– birch activated carbon additionally activated by H_2O_2 and doped by iron oxyhydroxide (Sorbent 3);

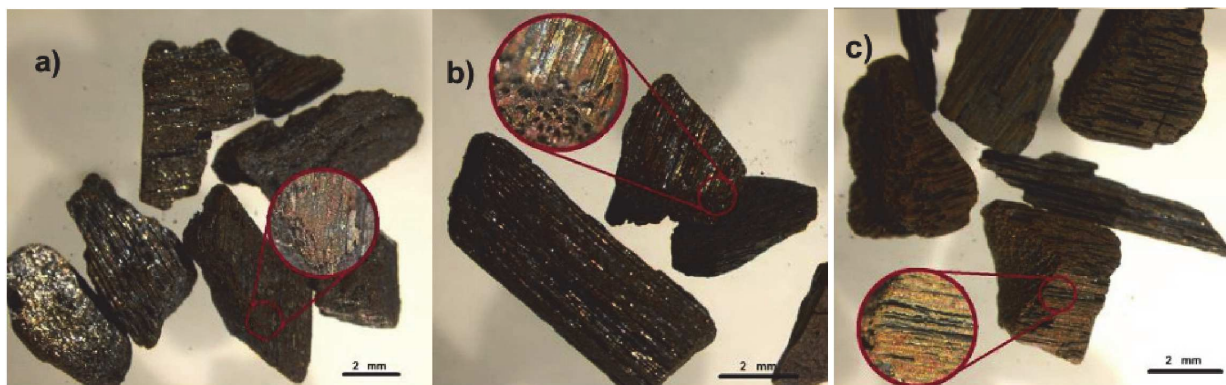– birch activated carbon additionally activated by $KMnO_4$ and doped by iron oxyhydroxide (Sorbent 4).

Stereo microscopy was obtained with magnification 1 and 5 by microscope Leica S8AP0.

For sorption experiments Na_2HAsO_4 solution were used. Portions (200 ml) of Na_2HAsO_4 solution (initial concentration of As(V) was 500 μg/l) were placed in a conical flasks (volume of flask is 250 ml) with screw caps. Sorbent dose was 0.5 g/l. Sorbents were dosed into flasks. After that flasks are placed on the orbital shaker. Shaking durations are: 5; 10; 20; 40; 90; 120 minutes. After sorption solutions were filtered throw glassfiber filter with pore size 1.2 μm.

Systea Easy Chem was used for determination of As(V) concentration in filtrate after sorption. Typical Systea methodic for orthophosphate determination was adapted for As(V). This methodic is based on usage of ammonium molibdate and antimony oxalate, formation of blue complex and photometric measurements with wavelength 880 nm.

3. Results and Discussions. According to the results of stereo microscopy, all doped sorbents (Figure 2) showed formation of iron oxyhidroxide layer on the surface of grains of birch activated carbon. Sorbent 2 (birch activated carbon doped by iron oxyhydroxide) and Sorbent 3 (birch activated carbon additionally activated by H_2O_2 and doped by iron oxyhydroxide) demonstrated the same view of iron oxyhydroxide layer.

Sorbent 4 (birch activated carbon additionally activated by $KMnO_4$ and doped by iron oxyhydroxide) (Figure 4) demonstrated higher efficiency of iron oxyhydroxide doping than other doped sorbents. Grains of Sorbent 4 are browner then grains of other sorbents due to larger thickness of iron oxyhydroxide layer.
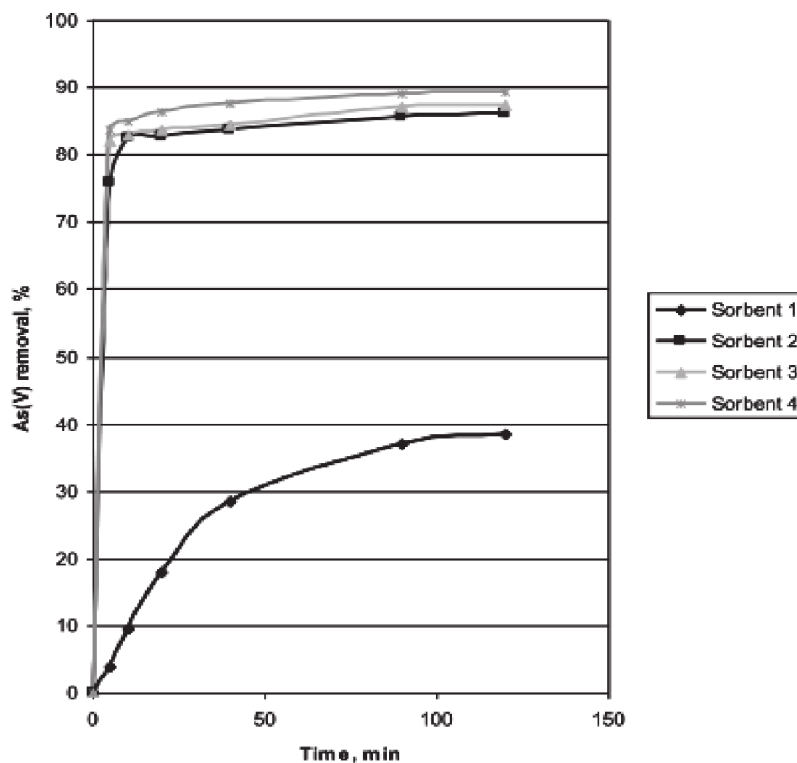

a – Sorbent 2 (birch activated carbon doped by iron oxyhydroxide); b – Sorbent 3 (birch activated carbon additionally activated by H_2O_2 and doped by iron oxyhydroxide); c – Sorbent 4 (birch activated carbon additionally activated by $KMnO_4$ and doped by iron oxyhydroxide)

Figure 2 – Stereo microscopy

Dopping by iron oxyhydroxide dramatically increased treating efficiency of birch activated carbon (Figure 3).

Pre-oxidized adsorbents (Sorbent 3 and 4) had higher efficiency of As(V) removal than adsorbent without additional activation (Sorbent 2), 87.4 %, 89.4 % and 86.2 %, respectively, for 120 min duration of sorption. Birch activated carbon additionally activated by $KMnO_4$ and doped by iron oxyhydroxide demonstrates higher efficiency than other doped sorbents. Additional activation by H_2O_2 or $KMnO_4$ increased amount of oxygen group on the surface of carbon. Iron preferred to bond with oxygen groups. So it increased efficiency of iron oxyhydroxide doping. Usage of $KMnO_4$ also doped carbons by MnO_2, which is effective in arsenic compounds removal.

But H_2O_2 and $KMnO_4$ are expensive and $KMnO_4$ is limited to sale due to its presence in precursor list of many countries, including Ukraine. So, additional activation by H_2O_2 or $KMnO_4$ dramatically increases adsorbent cost with insignificant increasing of effectiveness. Thus, birch activated carbon doped by iron oxyhydroxide without additional activation and pre-oxidation is the most perspective among these adsorbents.

Figure 5 – As(V) removal applying activated carbons with different preparation

4. Conclusions. According to the EU Directive the maximum permissible concentration of arsenic in drinking water is 10 μg/l. But in many countries (China, Chile, Malaysia, Taiwan, etc.) arsenic content in natural waters is much higher than this level.

Four adsorbents were used to determine the influence of preparation conditions on As(V) sorption efficiency applying activated carbon doped by iron oxyhydroxide: birch activated carbon (Sorbent 1); birch activated carbon doped by iron oxyhydroxide (Sorbent 2); birch activated carbon additionally activated by H_2O_2 and doped by iron oxyhydroxide (Sorbent 3) and birch activated carbon additionally activated by $KMnO_4$ and doped by iron oxyhydroxide (Sorbent 4).

Dopping by iron oxyhydroxide dramatically increased treating efficiency of birch activated carbon. But H_2O_2 and $KMnO_4$ are expensive and $KMnO_4$ is limited to sale due to its presence in precursor list of many countries, including Ukraine. So, additional activation by H_2O_2 or $KMnO_4$ dramatically increases adsorbent cost with insignificant increasing of effectiveness. Thus, birch activated carbon doped by iron oxyhydroxide without additional activation and pre-oxidation is the most perspective among these adsorbents.

References

1 Litynska, M., Tolstopalova, N., & Astrelin, I. (2017). Neutralization of arsenic pollutants, contained in natural waters: The theoretical analysis of solubility of some arsenates and optimization of the processes, 2(1), 1–8. http://doi.org/10.7508/jwent.2017.01.001

2 Litynska, M., Astrelin, I., & Tolstopalova, N. (2017). Ways of Arsenic Compounds Getting into Natural Waters. Modern Environmental Science and Engineering, 3(01), 50–60. http://doi.org/10.15341/mese(2333-2581)/01.03.2017/007

3 He, J., & Charlet, L. (2013). A review of arsenic presence in China drinking water. Journal of Hydrology, 492, 79–88. http://doi.org/10.1016/j.jhydrol.2013.04.007

4 Літинська, М. І., Астрелін, І. М., Толстопалова, Н. М. (2016). Забруднення природних вод арсеновмісними сполуками: Причини та можливі способи вирішення проблеми. Вода та водоочисні технології, 1(18): 13–22.

5 Малецкий, З., Митченко, Т., & Макарова, Н. (2012). Сравнительная оценка сорбционных свойств промышленных и экспериментальных гибридных материалов по отношению к примесям As(III) и As(V) в воде, Вода і водоочисні технології. Науково-технічні вісті, 21–30.