EFFECTIVE SOLUTION OF THE PROBLEM OF UTILIZATION OF PLANT WASTE IN THE INTERESTS OF ECOLOGY

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Introductions. Due to the prolonged growth of anthropogenic load, environmental pollution occurs. This leads to pollution of all elements of the biosphere - the atmosphere, the lithosphere and, above all, the hydrosphere. Today, significant quantitative and qualitative changes in water resources are taking place, which is caused by the discharge of insufficiently purified highly mineralized waters. The content of organic substances, petroleum products and heavy metal ions exceeds the established standards. Heavy metals get to natural sources with wastewaters of different industries. The discharge of untreated or insufficiently treated wastewaters, which contain a significant amount of heavy metal ions, causes enormous damage to the environment, for instance, the functioning of activated sludge is disturbed, hydrobionts is significant damaged, ability of reservoirs for self-purification decrease.

Therefore, the creation of low-waste wastewater demineralization technologies and the removal of heavy metal ions is an extremely important task today, which will improve the quality of treated water with a significant reduction in the amount of waste generated. Analysis of the literature data on the methods of purification of wastewater from heavy metal ions showed that there are a large number of

technological schemes based on methods of reagent precipitation, ion exchange, membrane methods, electrocoagulation, sorption [1–13].

A very promising and economically feasible method for the removal of heavy metals from aqueous solutions is biosorption with the use of inexpensive effective sorbents based on waste or by-products after processing of plant materials [9–13].

In order to create a complex low-waste technology of wastewater demineralization and purification from heavy metal ions, the paper defines rational conditions for the utilization of waste biosorbents as additives in the production of building materials or fillers of polymeric materials used in construction.

Aim. The aim of the work is to study the effect of spent biosorbents adding on the properties of cement.

Materials and methods. Grounded shells of walnuts (fraction with a particle size of 0.5-1.0 mm) with a content of cellulose 41.2%, lignin 37.5%, resins, fats, waxes 5.2%, mineral components 2.3 % were used as a raw material.

Modification was carried out by the partial hydrolysis of walnut shells with H_3PO_4 at 15-75 wt.%, at a solid to liquid ratio of 1:5, 100 °C for 60-180 min. By the end of the phosphorylation, the sample of the lignocellulosic biosorbents were filtered, washed with distilled water to neutral pH and air-dried to a moisture content to 5–6 wt.%.

Initial and modified shells were also used as additives in the composition of cement. To investigate the effect of biosorbents present in the composition of cement on its properties, the cement of I/500 type was used for this purpose.

Results and discussion. When evaluating the effect of unmodified walnut shell on the physical and chemical properties of cement, it is established that unmodified walnut shells play the role of a fine additive, that increases the normal density (on 6-19%) and accelerates the hardening (2.0-2.5 times) as can be seen from Table 1. The increase in normal density takes place due to the fact that more water is needed to form adsorption water shells around fine particles of plant material. The higher the content of the shell, the more water is consumed to obtain a paste of

normal density. The acceleration of hardening takes place due to the fact that the fine additive acts as a thickener (similar to clay).

Table 1

The effect of walnut shawls content in the composition of cement on its properties

Walnut shells content, wt. %	Normal density, %	Hardening time, min		Compressive strength, %		Coefficient of water removal, %
		begging	end	at the age of 2 days	at the age of 28 days	
-	24.0	62	140	100	100	4.1
1	24.5	60	130	98	98	4.5
3	27.1	45	90	68	95	6.0
5	28.4	40	75	65	80	6.0

The compressive strength of cement samples decreases with the increase in walnut shells content but the effect is a minor. This can be explained by the increased normal density of the cement paste. The coefficient of water removal also increases, but not significantly (from 4% to 6%), and the increase in the content of the sells above 3% doesn't lead to any changes in values.

The influence of the adding of 1.5% of modified walnut shell on the physicochemical properties of cement is shown in Fig. 2. The samples of biosorbents obtained during walnut shells modification with H_3PO_4 of different concentration during 120 min, were chosen for further investigations.

Data in Fig. 2 clearly show that the impact of modified walnut shells onto normal density is quite insignificant if compared to initial material. It is also obvious, that acid modification of shells leads to decrease in the beginning of hardening of cement due to the higher lignin content. Compressive strength increases in all cases due to the fact that lignin shows good binding properties. The coefficient of water removal changes insignificantly in comparison with initial material.

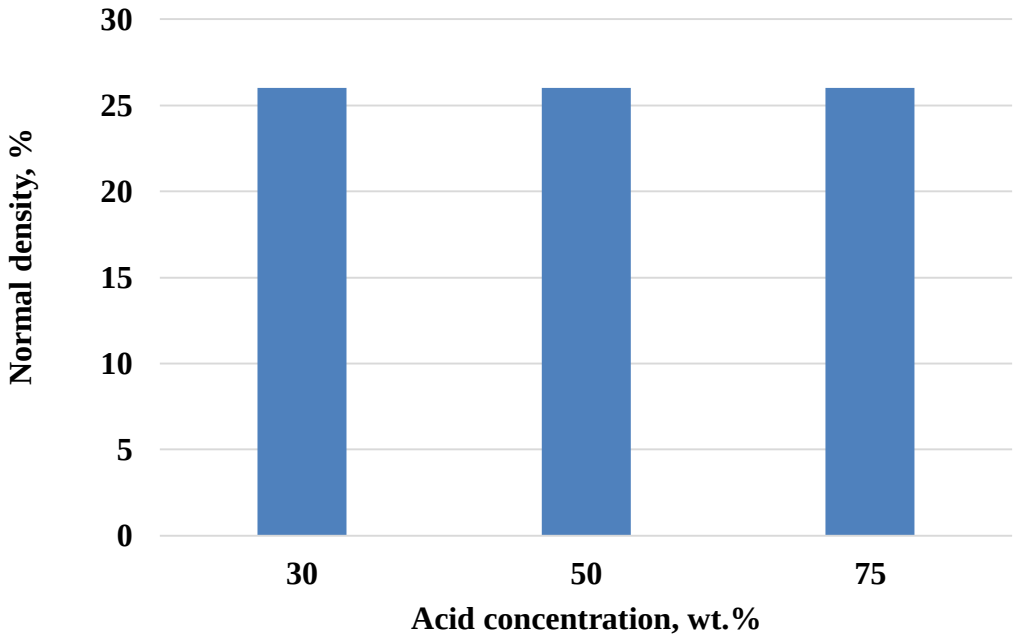

Figure 1. Effect of modified walnut shells content on cement normal density

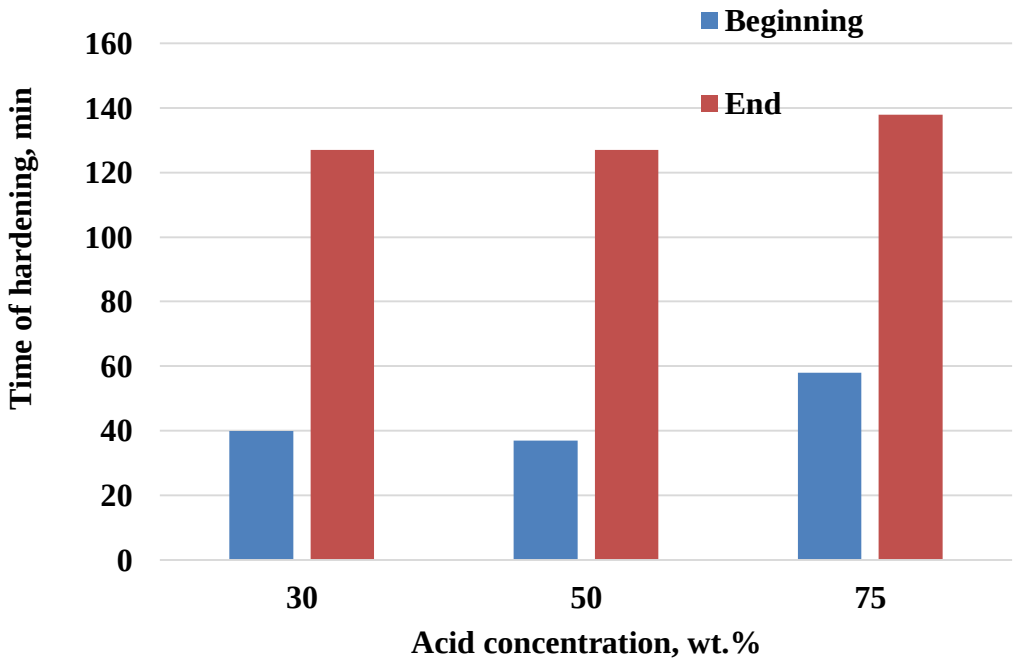

Figure 2. Effect of modified walnut shells content on cement hardening time

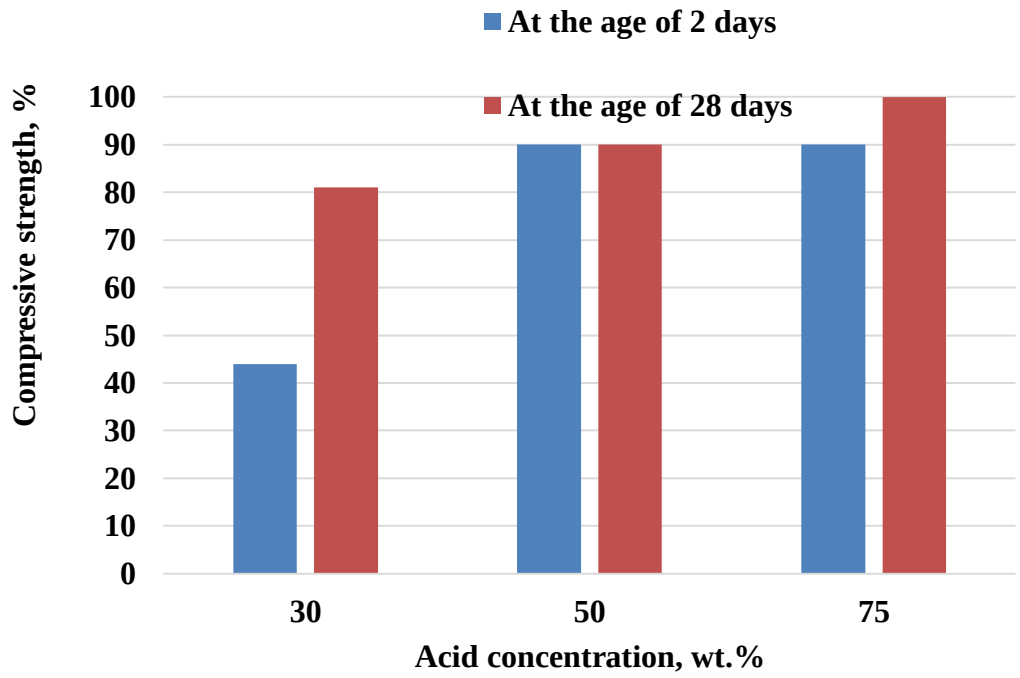

Figure 3. Effect of modified walnut shells content on cement compressive strength

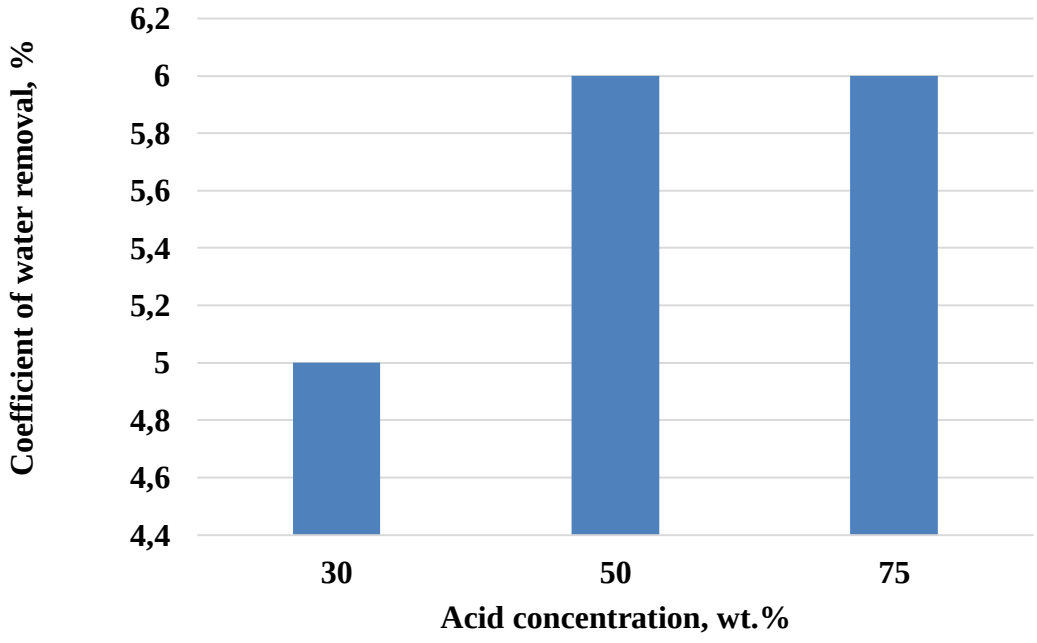

Figure 4. Effect of modified walnut shells content on cement coefficient of water removal

Thus, take into account positive effect of adding the shells on the physicochemical properties of the cement, it can be recommended to use this fact in development of effective method of its utilization through the application in cement production in quantity of 1-3 %.

Conclusions. It was found out that the shells act as a fine additive, that increase the normal density and accelerates the hardening time. The compressive strength of the cement samples with the application of lignocellulosic materials decreases slightly. Result show that phosphoric acid, which has been used to modify plant waste to increase their sorption capacity, has little adverse effect on the hardening time of cement.

References

[1] Гомеля М. Ефективність вилучення іонів важких металів з розведених розчинів іонообмінним методом / М.Гомеля, В.Іванова, І.Трус // Технічні науки та технології. – 2017. – № 4 (10). – С. 154-162.

[2] Гомеля М.Д. Застосування баромембранних методів в процесі очищення води від іонів важких металів / М.Д. Гомеля, В.П. Іванова, І.М. Трус, Є.С. Булгаков // Вісник Вінницького політехнічного інституту. – 2018. – № 3 С. 23-27.

[3] Трус І.М. Очистка води від іонів важких металів відстоюванням, нанофільтруванням та флотацією / І .М. Трус, М.Д. Гомеля, Є.В. Мельниченко, В.О. Мігранова // Технічні науки та технології. – 2019. - № 1(15). – С. 204-213.

[4] Гомеля М.Д. Очистка води від іонів міді при використанні магнетиту / М.Д. Гомеля, І.М. Трус, О.В. Глушко // Вчені записки Таврійського національного університету імені В.І.Вернадського. – 2019. – Том 30 (69) . – № 2. – С. 204-213.

[5] Trus I., Radovenchyk I., Halysh V., Skiba M., Vasylenko I., Vorobyova V., Hlushko O., Sirenko L. 2019. Innovative Approach in Creation of Integrated Technology of Desalination of Mineralized Water. Journal of Ecological Engineering. 20(8), 107–113.

[6] Trus I. Determining the influence of the medium reaction and the technique of magnetite modification on the effectiveness of heavy metals sorption / I. Trus, N.

Gomelya, G. Trokhymenko, N. Magas, O. Hlushko // Eastern-European Journal of Enterprise Technologies. –2019. – № 6/10 (102). – P. 49-54.

[7] Трус І.М. Використання сорбентів на основі магнетиту для очищення води від іонів важких металів / І .М. Трус, М.Д. Гомеля, Т.В. Крисенко, К.С. Сенькова // Технічні науки та технології. – 2019. - № 4(18). – С. 175-182.

[8] Trus I., Halysh V., Radovenchyk I., Fleisher H. 2020. Conditioning of iron-containing solutions. Journal of Chemical Technology and Metallurgy. 55(2), 486–491.

[9] Ковальчук А. Фосфорилювання шкаралуп волоських горіхів для підвищення ефективності очищення водних розчинів / А. Ковальчук, Т. Почечун, В. Галиш, І. Трус // Технічні науки та технології. – 2018. - № 2(12). – С. 236-244.

[10] Білявський С.А., Сарахман Р.Б., Галиш В.В., Трус І.М. Оптимізація технології одержання сорбентів з відходів рослинного походження // Екологічні науки. – 2018. - № 21. – С. 212-217.

[11] V. Halysh, I. Trus, A. Nikolaichuk, M. Skiba, I. Radovenchyk, I. Deykun, V. Vorobyova, I. Vasylenko, L. Sirenko. Spent Biosorbents as Additives in Cement Production. Journal of Ecological Engineering. 2020; 21(2):131–138

[12] A. Koliehova, G. Trokhymenko, N. Magas, N. Gomelya, I. Trus. Study of the Process of Electro Evolution of Copper Ions from Waste Regeneration Solutions. Journal of Ecological Engineering. 2020; 21(2):29–38.

[13] V. Halysh, I. Trus, M. Gomelya, I. Trembus, B. Pasalskiy, N. Chykun, G. Trokhymenko, I. Remeshevska. Utilization of Modified Biosorbents Based on Walnut Shells in the Processes of Wastewater Treatment from Heavy Metal Ions. Journal of Ecological Engineering. 2020; 21(4):128–133.