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USE OF SMALL-GRAIN DISTRIBUTED DRY MIXTURES IN TOXIC WASTE PROCESSING TECHNOLOGIES

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Анотація

Наведені результати дослідження фізико-механічних і радіаційно-захисних властивостей зразків дисперснонаповнених сухих сумішей підтверджують можливість використання матеріалів для переробки шкідливих токсичних відходів АЕС до отримання кінцевого продукту зі стабільними фізичними параметрами, що дозволить безпечне транспортування відходів і їх подальше захоронення у спеціалізованих сховищах.

Ключові слова: *радіоактивні відходи, промислові відходи, будівельні матеріали.*

Abstract

The presented results of the study of the physicomechanical and radiation-protective properties of samples of dispersed-filled dry mixtures confirm the possibility of using materials for processing hazardous toxic waste from nuclear power plants to obtain a final product with stable physical parameters, which will allow safe transportation of waste and its subsequent disposal in specialized storage facilities.

Keywords: *radioactive waste, industrial waste, building materials.*

Introduction

Current trends in the electricity market in Ukraine confirm the growing prospects for the development of nuclear energy. In terms of the number of power units, our state is among the top ten developed countries in the world. Compared to other sources of energy supply, natural reserves of raw materials for nuclear energy are predicted to last for millions of years. At the same time, the operation of nuclear power plants for the production of electricity is accompanied by the formation of radioactive waste (RW). Such harmful products are formed during the main technological process, as well as during routine and repair work.

Therefore, an important problem for nuclear energy enterprises is the creation of technologies for the safe management of radioactive waste at all stages of its existence. According to the order of the Cabinet of Ministers of Ukraine dated 19.08.2009 No. 990-r "Strategy of radioactive waste management in Ukraine", the problem of storing and processing such highly toxic products accumulated at nuclear power plants is acute. It is noted that the average specific formation of solid and liquid radioactive waste is 27 and 35.1 m3, respectively, per 1 billion kWh of generated electricity. According to statistical data, a high degree of filling of storage facilities with solid (from 30 to 70 percent) and liquid (from 21 to 76 percent) radioactive waste is observed in the territories of nuclear power plants[1-2].

Research results

Among the existing technologies for handling radioactive waste at the sites of operating nuclear power plants, collection, sorting and primary processing of waste to a state acceptable for transportation and temporary storage are provided. However, for further placement of technogenic products in specialized storage facilities, it is necessary to use additional technologies for immobilization of toxic substances for safe transportation with subsequent disposal. The main requirements for technologies for processing harmful products are: availability and economically justified cost of immobilization methods; creation of appropriate conditions for performing work in accordance with radiation safety requirements for performers and technological equipment; ensuring the obtaining of standardized characteristics of the final product with conditioned radioactive materials for their further transportation and disposal [1, 2]

The technologies proposed by scientists for processing and immobilizing radioactive waste involve the use of cementation, bituminization, or incorporation of products into a glass matrix. Depending on the physical state (solid or liquid) of hazardous materials, such specialized production processes differ. The most complex tasks are processes related to the immobilization of liquid waste. Thus, the technology for immobilizing reactor bottoms of nuclear power plants (low and medium-level waste) proposed by scientists from the V.D. Glukhovsky Research Institute of Binders and Materials (Kyiv) confirmed the possibility of obtaining a final processing product with regulated sample characteristics [3-4].

The obtained results of the study of the multifunctional properties of fine-grained metal-saturated concretes provide a basis for the possibility of using such disperse-filled mixtures for the immobilization of radioactive waste. Scientific developments in technologies for the production of radiation-protective materials using metal-saturated concretes allow us to state the prospects for the use of such special dry mixtures in technologies for conditioning and monolithicization of toxic materials in a special matrix. Such special dry mixtures can be used to transfer waste from a liquid state to a solid state, and due to the presence of a metal filler in the mixtures, the levels of external radiation from the final product will be reduced due to internal interactions of radioactivity flows with hardened neoplasms of inclusions of a dispersed-filled mineral matrix [5-6].

Table 1 presents the generalized results of the analysis of experimental studies of the special properties of samples manufactured using dispersed-filled dry mixtures [7-10]. The existence of a relationship between the formulation-technological, physicomechanical and radiation-protective properties of the dry mixture model samples has been confirmed. The information presented confirms the feasibility of using the obtained compositions of composite materials to convert hazardous toxic waste into a stable physical state for further transportation and disposal in specialized storage facilities.

Table 1 – Generalized results of sample studies

Sample series	Average density, kg/m^3	Compressive strength, kgf/cm^2	Water consumption, % mass	Water absorption, % mass	Linear attenuation coefficient of gamma radiation, E=121 keV
А	1760	46.8	44	4.8	0.128
Б	1910	64.6	58	5.6	0.164
В	2120	38.7	74	6.8	0.221

Notes: the content of metal filler for series of samples A is up to 20% by weight; for series B, respectively, 40% by weight; for series C, respectively, 60% by weight.

Conclusions

The presented results of the study of the physicomechanical and radiation-protective properties of samples of dispersed-filled dry mixtures confirm the possibility of using materials for processing hazardous toxic waste from nuclear power plants to obtain a final product with stable physical parameters, which will allow safe transportation of waste and its subsequent disposal in specialized storage facilities.

References

1. Hnes, L., S. Kunytskyi, and S. Medvid. "Theoretical aspects of modern engineering." International Science Group: 356 p. (2020).
2. Христич, О. В., Черепаха, Д. В. (2019). Радіозахисний металонасичений бетон поліфункціонального призначеня. Сучасні технології, матеріали і конструкції в будівництві.№ 2: 37-45.
3. Hladyshev, D., et al. Prospective directions of scientific research in engineering and agriculture. International Science Group, 2023.
4. Сердюк, В. Р., et al. "Пути использования дисперсных металлических шламов." (2004)
5. Лемешев М. С. Электротехнические материалы для защиты от электромагнитного загрязнения окружающей среды / М. С. Лемешев, А. В. Христич // Инновационное развитие территорий : Материалы 4-й Междунар. науч.-практ. конф. (26 февраля 2016 г.). – Череповец : ЧГУ, 2016. – С. 78-83.
6. Христич О. В. "Покриття із бетелу-м для боротьби з зарядами статичної електрики." Сучасні технології, матеріали і конструкції в будівництві 6.1 (2009): 29-31.
7. Березюк, О. В. "Радиоэкранирующие композиционные материалы с использованием отходов металлообработки." Инновационное развитие территорий: материалы 2-й Междунар. науч.-практ. конф., 25–27 февраля 2014 г.: 63-65.. Череповецкий государственный университет, 2014.
8. Лемешев М.С. Електропровідні бетони для захисту від статичної електрики // Перспективні досягнення сучасних вчених: матер. наук. симп., 19-20 вер. 2017 р. Одеса. 5 с
9. Березюк, О. В.. "Антистатичні покриття із електропровідного бетону." Сучасні технології, матеріали і конструкції у будівництві.№ 2: 26-30. (2017).

10. Христич О.В. Технологічні особливості формування електротехнічних властивостей електропровідних бетонів // Мир науки и инноваций. 2015. № 1 (1). Т. 10. С. 74-78.

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