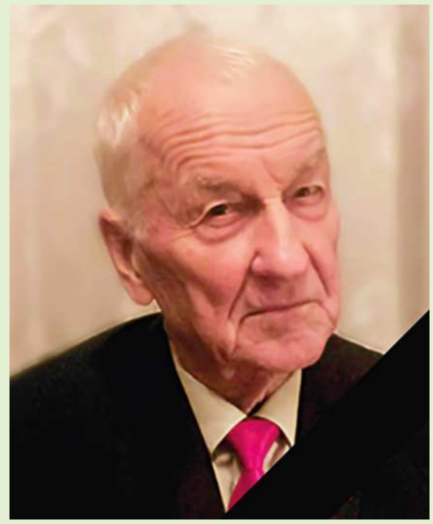
Пішов з життя видатний вчений, мудрий вчитель, чудова людина, доктор технічних наук, професор кафедри ТКД Київського національного університету будівництва і архітектури, дійсний член Академії будівництва України, секретар відділення «Будівельні матеріали і вироби» вказаної Академії, член Спеціалізованої вченої ради із захисту докторських дисертацій Національного технічного університету України «КПІ», лауреат премії Академії будівництва України ім. М.С. Буднікова Купрієнко Петро Йосипович.

Усі, хто знав Петра Йосиповича, любили його і поважали за чуйне ставлення до людей, велику душевну щедрість, добре серце і патріотизм.

Петро Йосипович був цікавою і мудрою людиною, чудовим викладачем, що володів високими професійними якостями. Він любив студентів і аспірантів. Його вклад в підготовку фахівців неможливо переоцінити. Сьогодні сотні його учнів успішно працюють по всій країні, з вдячністю згадуючи свого вчителя.

Світла пам'ять про Петра Йосиповича залишиться в наших серцях.

Редакційна рада Всеукраїнського науково-технічного і виробничого журналу «Будівельні матеріали та вироби» висловлює щирі співчуття, колегам, учням, рідним, близьким і друзям відомого вченого, мудрого наставника і педагога, чудової людини Купрієнка Петра Йосиповича



Купрієнко Петро Йосипович

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A COMPREHENSIVE SOLUTION OF ECOLOGY PROBLEMS AND RECYCLING OF INDUSTRIAL AND SOCIAL WASTE BASED ON THE «RECYCLING» TECHNOLOGY

КОМПЛЕКСНЕ ВИРІШЕННЯ ПРОБЛЕМ ЕКОЛОГІЇ І УТИЛІЗАЦІЇ ПРОМИСЛОВО-ПОБУТОВИХ ВІДХОДІВ НА БАЗІ ТЕХНОЛОГІЇ «РЕСАЙКЛІНГУ»

КОМПЛЕКСНОЕ РЕШЕНИЕ ПРОБЛЕМ ЭКОЛОГИИ И УТИЛИЗАЦИИ ПРОМЫШЛЕННО-БЫТОВЫХ ОТХОДОВ НА БАЗЕ ТЕХНОЛОГИИ «РЕСАЙКЛИНГА»

Annotation. The article presents a concept of a comprehensive solution developed to solve specific problems related to environmental pollution problems. The main instrument to solve these problems is to use nanomodified natural aluminosilicate in the process of water treatment with subsequent recycling of the exhaust sorbent, together with wastes of different nature, as charge ingredients in production of ceramic products.
As algorithmic sequence of work stages in water purification section according to the Project is given as an example. The work also contains a list of different kinds of waters containing inclusions of various nature which are subject to purification, where natural aluminosilicates-based nanosystems work effectively as sorbents. This large-scale Project is given in the form of a presentation and is ready for implementation.
Keywords: aluminosilicates, comprehensive solution, nanomodification, recycling/waste disposal, ceramic products, water treatment products.
Анотація. Розроблена концепція комплексного вирішення конкретних завдань, пов'язаних з проблемами забруднення навколишнього середовища. Основним інструментом у вирішенні цих завдань є використання наномодифікованого природного алюмосилікату при очищенні води з подальшою утилізацією відпрацьованого сорбенту, а також відходів різної природи в якості інгредієнта шихти у виробництві керамічних виробів.
Як приклад, приводиться алгоритмічна послідовність узагальнених етапів проведення робіт при виконанні проекту в частині очистки води. Приводиться перелік вод, що містять домішки різної природи і підлягають очистці, де ефективно працюють в якості сорбентів наносистеми на основі природних алюмосилікатів. Масштабний проект в цілому приведено у вигляді презентації і готовий до реалізації.
Ключові слова: алюмосилікати, комплексне рішення, наномодифікування, утилізація, керамічні вироби, продукти водоочистки.
Анотация. Разработана концепция комплексного решения конкретных задач, связанных с проблемами загрязнения окружающей среды. Основной инструмент в решении этих задач - это использование наномодифицированного природного алюмосиликата при очистке воды с последующей утилизацией отработанного сорбента, а также отходов различной природы в качестве ингредиента шихты при производстве керамических изделий.
В качестве примера, приводится алгоритмическая последовательность обобщенных этапов проведения работ при выполнении проекта в разделе очистки воды. Приводится перечень вод, содержащих добавки различной природы и подвергаются очистке, где эффективно работают в качестве сорбентов наносистемы на основе природных алюмосиликатов. Масштабный проект приведен в виде презентации и готов к реализации.
Ключевые слова: алюмосиликаты, комплексное решение, наномодифицирование, утилизация, керамические изделия, продукты водоочистки.

Problem Statement

Transforming industrial and household residual waste, pre-prepared in form of powder, paste or suspension, into materials or articles for construction industry includes development of specific technological processes, chosen according to the industrial and household wastes' nature, their chemical composition and amount.

The suggested technology is based on a recycling technology of manufacturing technical ceramic building materials using industrial and household residual waste of various nature and origin as a component of furnace charge matter, according to the matrix+matter method.

This recycling technology's scientific concept is based upon colloids chemistry of materials science and includes using certain nanotechnology elements enabling to effectively solve difficult problems related to the particular condition of the environment. As of today, the preliminary scientific research results have been obtained, as well as the technology implementation testing results, and pilot samples of building materials have been manufactured using the ceramic technology, altogether confirming the significance of the suggested idea [1-9]

We offer a number of recycling based technological solutions to manufacture ceramic materials of different construction use (road construction elements, ceramic gravel, blocks for construction of outbuildings) where different nature industrial and household residual waste is used as a component of the charge matter for manufacturing of ceramic articles [Table 1, Scheme 1].

Project's Rationale

Industrial and social waste, household garbage and domestic refuse is an artificial newly created environment component which is clearly visible to everyone and is one of the main factors influencing our country's living environment quality directly, immediately and comprehensively. Therefore theoretical and practical development of technologies of waste recycling is a part of the Sustainable Development trend, it is essential and has a potential to be used with practical results contributing to the higher level of safety of people's life.

The technology uses a ceramic-making method with obvious mandatory phase when an intermediate product of a building article undergoes an annealing process at 10000C temperature or more, which results in the solid-state reaction allowing binding waste's hazardous chemical components inside ceramic matter as its structural component or simply containing it within the material which is insoluble and doesn't leak poison into environment. As an example, there are measured data we've obtained for testing implementation of nanomodified natural aluminosilicates for treatment of electroplating wastewater with subsequent recycling of the resulting sludge as a charge component in ceramic bricks manufacturing.

The suggested project allows us to solve environment protection problem in two ways, namely: it allows recycling of certain waste matter, such as sludge or exhaust sorbenti, generated as a result of various wastewaters purification processes, and which previously had had to be disposed of and stored under special conditions; whereas another project's aspect is recycling of waste building materials, such as ceramics, lime, sand, wood or paper after necessary technological preparation.

The analysis of tested samples' technical properties shows that, according to every classification attribute and value, defined in regulatory documents, the sludge generated as a result of treatment of industrial wastewater effluent with nanomodified sorbents can be utilised through adding it to furnace charge matter in the process of ceramic bricks manufacturing on currently operating plants.

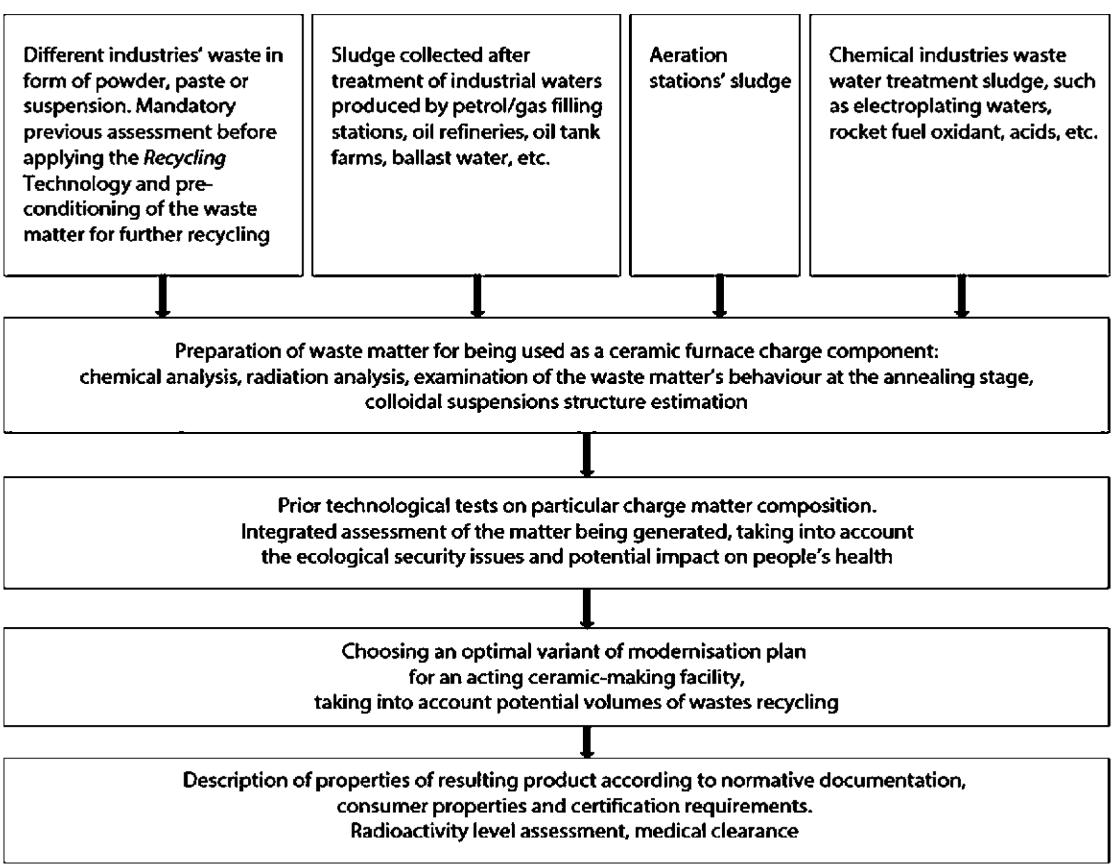
Manipulating charge composition and the amount of the nanomodified supplement added might potentially lead to a discovery of other still hidden useful effects, like those that scientists and engineers often observe when working with nanosystems. Here the crucial significance is attributed to such factors as modifier's nature and oxide or aluminosilicate surfaces' level of modification. The reason for this is the system's deficiency growth as a result of the annealing process of a pre-formed and dried sample containing nanomodified aluminosilicate which stimulates ceramic material sintering process. This leads to the increased thickness of crystal structure resulting in overall enhanced firmness and better operational and consumer characteristics.

Analysing earlier results obtained after previous tests when nanomodified aluminosilicates were applied for treatment of wastewaters polluted with ions of heavy metals, petrochemicals (soluble and emulsions), rocket fuel oxidizer and etching solutions, it is possible to draw a conclusion that the suggested innovative project is realistically feasible. The given data lets us affirm confidently that nanomodified aluminosilicates can be widely implemented for solving global problems of water purification and environment protection (Scheme 1, Table 1).

As an example, the project implementation's scheme in its section devoted to the water treatment technology is being focused at.

Industrial implementation of the Technology requires going through several stages, namely:

- assessment of contamination's chemical composition and waste water volume;
- familiarization with the already existing industrial wastewaters treatment technological schemes and equipment;
- choosing an optimal mode of the selected sorbent modifying method according to the sorbent's minimal possible amount criterion defined through test experiments;
- development of a new technological scheme for treatment of industrial wastewater, utilizing either new or already existing equipment, or modernizing it if necessary;
- industrial wastewater treatment technological procedures development.

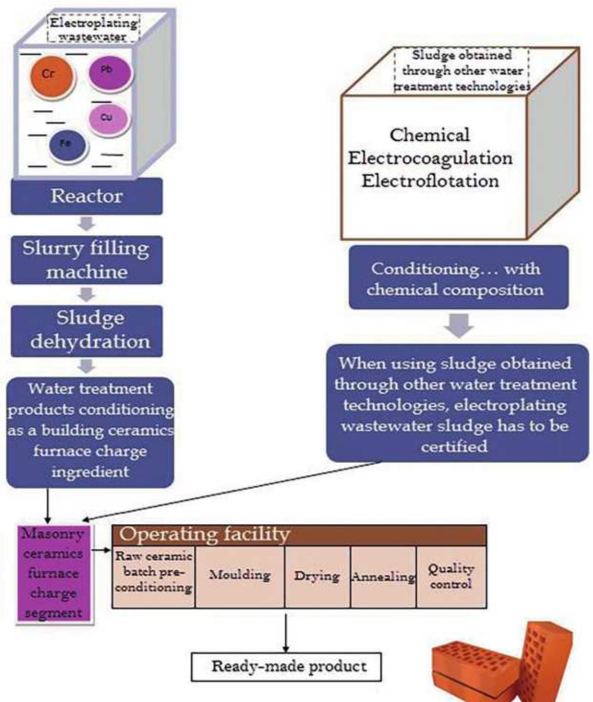


Scheme 1. The Innovative Recycling Technology Operating Model

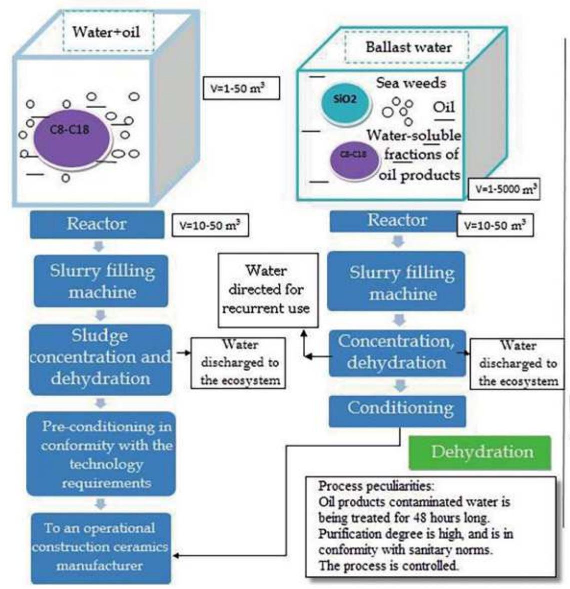
Table 1.

The list of technological processes and products resulting from industrial and household residual waste recycling

The list of industrial and household residual waste types which are subject to recycling	Industries, resulting product
Sludge collected through the process of purification of salt or fresh water contaminated with petrochemicals	Generation of organo-mineral nanocomposites. Raw material for ceramic building materials manufacturing
Sludge resulting from treatment of electroplating wastewater	Components of charge matter for ceramic building materials manufacturing: bricks, tiles, ceramic sanitary ware
Sludge resulting from remediation of etching solutions in steel pipe manufacturing	Ceramic building materials manufacturing component
Aeration stations' sludge processing resulting products (still being developed)	Technical ceramic products manufacturing: industrial space, ceramic rubble
Rocket fuel oxidant, reprocessed product	Production of nanocomposites, of ceramic building materials manufacturing charge matter components, mineral fertilizers



Scheme 2. Waste Recycling Technology



Scheme 3. The Treatment of Petrochemicals-Contaminated Water and Sludge Recycling Work Sequence Technological

Table 2.

Applying modified aluminosilicate for electroplating wastewater treatment technological tests results

Industrial wastewaters characteristics	Before-treatment amount, mg/l	After-treatment amount, mg/l	Decontamination duration, hours
Вода гальваничного виробництва			
Cr	28	<0,02	
Cu	34	<0,05	1,5-2,0
Cd	2,4	unavailable	
Fe	38	0,02	
Ni	12	<0,05	
Suspended substances of different dispersive degree			
<0,1 µm	55	0,8	0,5
>10 µm	250	1,5	0,5
Polydisperse suspended matter	7500	4,0	1,0

Table 3.

Assessment of the efficiency of water treatment from soluble fractions of petroleum products

Soluble oil products fractions	Before-treatment soluble oil products fractions amount, mg/l	After-treatment soluble oil products fractions amount, mg/l	Treatment duration, hours	Purification degree, %
C8-C26 benzene	5-35 up to 150	0,03 0,1	2,0 2,0	99,99-91,43 99,99

Table 4.

Tests to evaluate technological properties of ceramic bricks charge matter containing sludge supplements resulting from industrial sewage treatment

Indicators	Charge matter index, composition					
	Ch_0	Ch_2	Ch_2	Ch_3	Ch_4	Ch_5
Moulding humidity, %, AH	23,35/ 20,22	24,63/ 19,80	25,19/ 20,80	24,49/ 19,70	25,24/ 19,80	25,80/ 20,40
Desiccation sensitivity, C	>180	>180	>180	>180	>180	>180
Air-drying shrinkage, %	6,61	6,40	6,24	6,62	6,54	6,70
General shrinkage, %	6,70	6,54	6,74	6,72	7,04	7,02
Average density, g/cm^3	1,55	1,58	1,58	1,54	1,58	1,50
Compression limit, MPa	18,4	19,2	20,0	19,8	20,4	21,8
Water absorption, %	22,28	21,50	21,20	21,44	21,0	20,54

Ch_0 is a usual brick-making plant charge mix;
Ch_2, Ch_2 are samples of charge matter incorporating additional sludge, consisting of electroplating manufacturing wastewater treatment products, 1 and 3 % mass, correspondingly;
Ch_3, Ch_4 contain 1.3 % of sludge mass after treatment of water-soluble petrochemical fractions contaminated water;
Ch_5 contains 3 % of sludge mass after treatment of ballast water (seawater).

This approach pertains to the first stage of implementation of the large-scale project of industrial wastewaters purification and preparation of resulting by-products to be further used in the Recycling Technology.

The general scheme of the large-scale project's full cycle is given below, in the form (Scheme 2, Table 2, Scheme 3, Table 3).

Using this technology will considerably decrease industrial wastewaters treatment expenses as compared to the reagent purification method, which is currently used in industries.

According to this technology, the modified sorbent consumption ranges from 0.3 to 1.0 kg for 1 m3 of industrial sewage.

Resulting sludge collected after treatment of industrial sewage with nanomodified natural aluminosilicate sorbents can further be recycled as an additional ingredient to a charge mix in manufacturing of masonry construction ceramic elements, such as ceramic bricks and blocks, ceramic rubble, etc. (Table 4).

Test experiments to assess the ceramic bricks manufacturing charge matter containing nanomodified montmorillonite (bentonite) samples, spent as a sorbent, demonstrated resulting increase of product's mechanical strength with simultaneous maintaining of other important technological parameters within tolerance levels. Modifications of the charge's basic composition and alterations of nanomodified component's amount followed by technological pre-tests will certainly lead to further discovery of other useful and still unpredictable effects, since such discoveries are quite common among scientists and technic specialists working with nanosystems. In this sense it's worth mentioning the effect of increased density of nanomodified oxide compositions, which could serve as model systems. An optimal degree of charge's modification leads to the an after-annealing increase of density sample within a 0.2 – 0.3 g/m3 range, and at the same time the required density level of a formed sample made from the charge having pressed nanomodified powder as its main component could be achieved at lower pressure values [Table 4].

Unlike unmodified samples, the research shows possibility of regulation of structuring process through ferrite powders surface modifications. α surface modification degree plays a crucial role. System's deficiency growth, occurring in the process of the pre-formed and dried sample's annealing, stimulates the process of generation of liquid defects, which, in their turn, initiate fluid flowing. Altogether it results in increased density of crystal structure of modified samples after the annealing process, as compared to that of a control sample.

Analysis of the said scientific results allows us to make a definite conclusion that the suggested innovative project has the big perspective. This technology permits to reach high levels of industrial wastewater purification and is commercially cost-effective.

The given data lets us make a claim that nanomodified natural aluminosilicates can definitely be widely used to solve the global problem of water treatment with removal of heavy metals ions and water-soluble fractions of oil and petrochemicals, including ballast water (seawater).

The results acquired from our scientific studies and technological experiments, a part of which has been relayed in this article, make it possible to suggest these findings to other interested parties as a solution for particular tasks at different industries or as a form of commercial activity.

The project suggests treatment of various nature industrial waste effluent with actual removal of pollutants. Then the removed matter from the treated water is dehydrated, stored and, when its amount reaches a certain prerequisite level, it is collected and dispatched to some operating building ceramics manufacturers or, alternatively, can be used as a filling of a furnace charge. The waste matter is added in a form of sludge of a particular concentration of its solid phase. The ceramic furnace batch moisture level is then to be adjusted, directly at a product moulding section: bricks, tiles, building blocks, keramzit, lightweight materials etc.

An application of nanomodified natural aluminosilicates as sorbents according to the technology of purification of various nature industrial wastewaters combined with sludge's subsequent recycling promotes environment improvement, modernisation of ceramics manufacturing technologies, especially in the aspect of batch's plasticity regulation, modernisation of the annealing process and of influence of addition of wastewater treatment products at structure and texture of ceramic products, their density and durability, and their consumer performance.

Conclusion

Technological solutions described in the article are theoretically and practically well-grounded, and approbated at a real production facility. The Project has a definite investment potential, on condition that recycling and ecology problems are treated with a serious approach. At the moment there is a possibility to implement this technology to solve particular immediate problems of domestic, municipal or industrial wastewater treatment problems, and also to prevent a negative influence of a wide range of different aggressive chemical compounds and substances on the environment. In our opinion, scientific works on treatment of water, including seawater contaminated with petrochemicals, heavy metals ions or rocket fuel oxidant, considered in combination with the Recycling technology, deserve a special attention.

References:

1. Rebinder P.A. New technology of disperse materials // Вести. An The USSR - 1964 - №8. - p. 26-28.
2. Ovcharenko F.D. Colloidal and chemical phenomena in the processes of composite materials production // Mechanics and technology of composite materials. - Sofia BAN, 1979 - p.417-421.
3. Kruglytsky N.N. Questions of colloid and chemical materials of inorganic composites // Physical and chemical mechanics and lyophilism of disperse systems. -19895. - vp.17. - p. 36-55.
4. P.I.Kuprienko Regulation of colloid-chemical and technological properties. Technical suspensions. - K .: Scientific Opinion. 2000 - 287s.
5. Kulsky L. A., Kuprienko P.I., Matvienko N.I. Influence of heat treatment on the rheological properties of sewage sludge // Chemistry and water technology. - 1979 - 1, No. 2. - p. 16-19.
6. Pavlova L.A., Kuprienko P., Maes A., Wilson M.J.// Targeted modification of the Ukrainian clays for water purification from organic pollutants. Scietific Israel / - Technological Advantages. V.I, # 3, 1999, p. 43-53.
7. Kuprienko P.I. Nanomodified natural aluminosilicates in solving global problems of water purification // Materials of the 18th Symposium IGWT Technologies and Innovations for a Sustainable Future: Prospect of Commodity. Rome, Italy 24-28 was made in 2012 Electronic.
8. P.Kuprienko Colloid - Chemical Science of materials in materials and Goods technology // Materials 17-20 «IGWT Symposium» September 21-25, 2010. Bucharest, Romania with. 969-975.
9. Kuprienko P.I., Dyuhilova N.A., Kuprienko N.P. Nanomodified natural aluminosilicates in the technology of industrial wastewater treatment and production of ceramic building materials. // Building materials, products and sanitary equipment. - Scientific and technical collection. Vp.57. - 2016 - p.68-76.