Список літератури

1. **AutoCAD 2006** / Подробное иллюстрированное руководство // Учебное пособие / под ред. **А. Г. Жадаева**. — М. : Лучшие книги, 2006. - 240 с.

2. **Р.Н. Квэтний, І.В. Богач, О.Р. Бойко, О.Ю. Софина, О.М. Шушура** / Комп'ютерне моделювання систем та процесів. Методи обчислень // **Квэтний Р.Н., Богач І.В., Бойко О.Р., Софина О.Ю., Шушура О.М. -** Навчальний посібник / http://posibnyky.vntu.edu.ua/k_m/t1/zm1..htm

3. **О.Ф. Бабічева, С.М. Єсаулов** / Комп'ютерне проектування електромеханічних пристроїв // **Бабічева О.Ф., Єсаулов С.М. -** Навчальний посібник / Харків: ХНАМГ / 2009. - 281 с.

4. **С.Г. Ушаков, Ю.Н. Муромкин, Б.Л. Шелыгин** / Тепловой поверочно-конструкторский расчет котлов с естественной циркуляцией // **Ушаков С.Г., Муромкин Ю.Н., Шелыгин Б.Л. -** Учебное пособие / Иваново, 2004. - 116 с.

5**. Х.Н. Ясавеев, А.Г. Лаптев, М.И. Фарахов** / Модернизация установок переработки углеводородных смесей. Казань: / Издательство «ФЭН», 2004. – 307 с

6. **В.П. Большаков, А.Л. Бочков, А.А. Сергеев** / 3D-моделирование в AutoCAD, КОМПАС-3D, SolidWorks, Inventor, T-Flex // **Большаков В.П., Бочков А.Л., Сергеев А.А.** – Учебный курс – СПб.: Питер, 2011, - 336 с.: ил.

7. **А. Магомедов** / Трубопроводы 3D — в три шага / САПР и графика 4`2009

8. **О. Зыков /** Металлоконструкции 3D. Изучаем новое приложение в машиностроительной линейке АСКОН / САПР и графика 1`2009.

9. **Т.Ю. Соколова** / AutoCAD 2009 для студента. Самоучитель. – СПб.: Питер, 2008. – 384 с.: ил. –(Серия «Самоучитель»).

10. **ANSYS 5.7 Thermal Analysis Guide /** http://orange.engr.ucdavis.edu/Documentation12.0/120/ans_the.pdf

11. **А.А Алямовски**й / COSMOSWorks. Основы расчета конструкций на прочность в среде SolidWorks / ДМК Пресс – 786 с.

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ANALYSIS OF EFFICIENCY OF BIOLOGICAL TREATMENT OF DOMESTIC WASTEWATER APPLICATION AT PRIVATE LOCALITY NEAR THE SOUTHERN MINING AND ORE-DRESSING COMPLEX

Resulting from intensive construction activity at localities without canalization system with creation of living environment and such constructions as infectious diseases hospital, camping centers, small agro-processing enterprises problem of wastewater treatment of such objects by establishment of scientifically based, reliable, compact, low energy technological schemes and designs systems of low productivity take center stage. Not all the treatment facilities and wastewater treatment methods provide quality wastewater treatment and give reliable operations or require highly qualified personnel presence. Therefore improvement of existing and development of more effective and safe in terms of Ecology wastewater treatment methods is urgent. Using of remediation facilities is one of the perspective trends of wastewater treatment. Treatment facilities combining basic construction elements of land treatment with hydrobiocenosis of bio-plateau or bioponds with higher water plant.

BTP technology uses processes of sedimentation, filtration and natural self-purification of water objects based on the ability of higher water plants, aquatic flora and microorganisms to carry out destruction, transformation and accumulation of organic and mineral suspended solids, oil, heavy metals and bacterial contamination.Using advanced technologies based on the actions of higher water plants nowadays are environmentally acceptable and economically promising direction in wastewater treatment systems. Distribution of such technologies can contribute to improving the environmental situation at localities without canalization system in Krivoy Rog.

Key words: biological treatment of water, bio-plateau, higher water plant.

Problem and its relation with scientific and practical tasks. Domestic wastewater treatment at localities without canalization system under conditions of complex environmental situation requires competent wastewater treatment (in accordance with discharge to water objects regulations) [1,6,10].

Resulting from intensive construction activity at localities without canalization system with creation of living environment and such constructions as infectious diseases hospital, camping centers, small agro-processing enterprises problem of wastewater treatment of such objects by establishment of scientifically based, reliable, compact, low energy technological schemes and designs systems of low productivity take center stage [2].

Not all the treatment facilities and wastewater treatment methods provide quality wastewater treatment and give reliable operations or require highly qualified personnel presence. Therefore im-

provement of existing and development of more effective and safe in terms of Ecology wastewater treatment methods is urgent. Using of remediation facilities is one of the perspective trends of wastewater treatment. Treatment facilities combining basic construction elements of land treatment with hydrobiocenosis of bio-plateau or bioponds with higher water plant [1,7,12].

Research and publications analysis. Wastewater treatment method based on using water objects self-purification processes with higher water plant (HWP), water flora and micro-organisms is widely used in Western Europe (UK, Denmark, Switzerland, Finland, Spain, France, Germany, Norway, Austria, Estonia), and also USA, Canada, New Zealand, Ukraine [9, 11, 12].

Bio-plateau technology is used for domestic, industrial, agricultural, rainwater, leachate hard domestic waste [7]. Bio-plateau facilities have been designed and implemented in Donetsk, Zaporizhia, Luhansk, Kharkiv, Ternopil and Transcarpathian Regions [3].

Problem statement.

Objective: to establish ecological expediency and to define advantages of using biological methods of wastewater treatment. *Tasks:* - to determine the effect of wastewater on environment; - to consider fitotechology method and its application at wastewater treatment; - to investigate removal of pollutants mechanisms at bio-plateau facilities; - to investigate fitotechlogies efficiency at wastewater treatment for improving ecological situation at private locality near the Southern mining and ore-dressing complex.

Object: private locality near the Southern mining and ore-dressing complex without canalization system. *Subject:* wastewater treatment at biologically engineered facilities. *Methods:* using horizontal and vertical bio-plateau.

Material statement and its results. Privy with drainage for wastewater treatment is mostly used at the private locality near the Southern mining and ore-dressing complex. Advantage of such construction is its simplicity. Disadvantage is that wastewater leaks into the ground and reaches the groundwater of the Iguletz River and makes environment threat to homeowner and his neighbors' welfare within radius of 30 m from drain privy. There is also odor. In addition there is possibility of wastewater leakage when the drain privy is overfill of wastewater or settled sludge. Besides environmental pollution the house owner faces the problem of water siphonage. At the bottom of the drain privy sludge, grease, feces, vegetables cleaning accumulate and ground absorbing possibility reduces [3]. It is not profitable for the house owner to use sewage pipe cleaner services and pay for wastewater disposal which is 95% consists of water [1]. When wastewater reaches water objects there is oxygen debt and stink damp concentration and blue-green algae, blue-green blanket reproduction, water blooming or eutrophication that causes mass water organisms extinction especially industrial fish. The presence of large quantities of organic matter in the ground where special type of sludge contains there are hydrogen sulfide, ammonia, metal ions. Such water is unfit for drinking and recreational need [3].

Great amount of wastewater contains detergent agents. Which contain surface-active substances (SAS) and various additives alcaine, neutral bath, peroxide, elements preventing pollution agents' resorptions. Detergents falling into the water, causing foaming, degrade the water organoleptic properties, disrupt the oxygen metabolism, toxic effects on fauna, and worsen processes of biological oxidation of organic substances that prevent wastewater biological purification [1]. In addition untreated water may contain pathogens of various infectious diseases.

One of the most effective, ecological and promising methods of wastewater treatment at localities without canalization system is using biologically engineered facilities. Bioengineering treatment plants (BTP) are treatment facilities that combine basic construction elements of ground treatment with hydrobiocenosis of bio-plateau bioponds with higher water plant (HWP). A distinctive feature of BTP is formed biocenosis which quantitative and qualitative characteristics are formed under the direct and indirect effects of HWP. Design of such construction provides treated fluid flow movement in a horizontal plane - through thickets of macrophyte, in the vertical plane - through the root-saturated layer of soil micro flora rich and well-developed algocenosis. The area of BTP depends on the wastewater amount [5].

Natural process is a great advantage of BTP in accordance with biological treatment in aeration chamber where biodestruction processes are stimulated and are different from natural. That leads constant supporting necessity (mostly aeration) which consists of power consumption, constant control and appropriate maintenance [4]. BTP technology uses sedimentation processes, filtration and natural self-treatment of water objects based on the ability of higher water plant, water flora and microorgan-

isms to make destruction, transformation and accumulations of organic and mineral solids, oil, heavy-metal ions and bacterial contamination.

Vertical infiltration bio-plateau. At vertical infiltration bio-plateau wastewater comes from the bio-plateau surface to the bottom vertically, oxygen comes to the system due to air diffusion from the atmosphere and through the plants roots. Nitrification processes in type bio-plateau plants occur more rapidly than in the horizontal therefore wastewater containing high nitrogen concentration treatment is possible. The disadvantages of this bio-plateau type are complex treatment process system and creating favorable conditions for insects [6, 9]. Every 10-15 years it is necessary to remove sediment from the surface of the vertical filter without violating the filter layer. This mineralized sediment moisture content of 20-30% can be used as fertilizer peat.

Horizontal infiltration bio-plateau. Wastewater moves through the downloading layers from one end to the other almost horizontal. It consists of one or more sections, which include waterproof coating downloading layers and plants. Compared with surface bio-plateau at such structures big hydraulic load and high efficiency of wastewater treatment for BOD, COD are achieved, solids, heavy metals, and at the site of treatment facilities virtually no odor and insects presence. Horizontal infiltration bio-plateau is widely used in the USA, Japan, Australia and Europe. The disadvantage of such construction type is only that the ability to remove nitrogen is slightly lower than vertical type bio-plateau.

Mixed type bio-plateau. For treatment efficiency improving it is often used different combinations of the above-mentioned bio-plateau types that leads to different fluid flows formation in one facility.

For achieving the required quality of wastewater treatment biologically engineered plants with cascade structure are used where each step of the cascade operates as an independent structure and removes necessary part of the pollution. Thus, a cascade of 3-4 plants eliminates pollution of wastewater, even in the first year of BTP.

Tanks system and water regulators are necessary for effective work of both types of BTP (horizontal and vertical filtering) [8]. Compared with traditional treatment methods removes bio-plateau system is better for suspending solids, ammonia, phosphates and surfactants (Table 1).

Table 1

Treatment efficiency %

Treatment technology	Suspended substances	BOD	COD	Ammonia	Surfactants	Phosphates
Traditional	62,6	58,8	61,6	8,4	2,1	4,1
Bio-plateau	76,5	92.0	83,3	1,4	4,6	3,0

BTP advantages:

Unproductive land can be used for bioengineering treatment plant constructing; - Constructing does not require high-qualified workers and can be implemented by local construction companies with traditional technical means; - Operation does not require electricity consumption or chemical reagents;

BTP life term without any repairs is more than 30 years as it's a self-repairing system; - HWP on the surface of bio-plateau provides deodorization of domestic wastewater so sanitary protection zone of treatment facilities complex can be about 50 m; - BTP is a part of natural landscape; - BTP service may involve a small number staff that saves construction and operating costs; BTP provides stable efficiency in summer and winter periods [2].

According to the results of the INCOCOPERNICUS project in Kharkiv region, wastewater treatment is provided by bio- plateau BODfull from 90 to 95% (5-6 mg / l), COD of 85 to 95% for suspended solids from 95 to 99% (4-5 mg / l) on petroleum from 0 to 0.05 mg / l in detergents than 85% mineralization from 20 to 99% transparency treated water reaches 30 cm according to Snellen for bacteriological from 98 to 99%[8].

Table 2

Treatment efficiency of mixed bio-plateau

Indexes	Sampling				Treatment efficiency %
	Entry	Pond	Vertical bio-plateau	Horizontal bio-plateau	
2,25			16,97	26,99	
3,50			1,60	0,25	
Suspended solids, mg/dm^3	284,99	212,75	25,02	13,58	95,23
Dissolved oxygen mg/dm^3	2,29		1,06	6,83	

COD, mgO2 / dm^3	188,57		28,22	23,77	87,40
BOD, mgO2 / dm^3	77,68		8,83	3,79	95,12
Permanganate oxidation mgO2 / dm^3	30,68		6,68	6,17	79,89
Ammonia nitrogen, mg/dm^3	54,86		40,11	26,89	50,99
Orthophosphate, mg/dm^3	0,55		0,24	0,25	55,24
Phosphorus general, mg/dm^3	6,33		7,53	5,21	17,69
Surfactants, mg/dm^3	0,337		0,085	0,043	87,19
Chloride, mg/dm^3	44,21		51,33	42,43	4,04
Sulfates, mg/dm^3	262,57		239,04	244,84	6,75
Bacterial contamination Total Coliform (TC index (x105))	8016,4		302,73	13,32	99,83

It eliminates odor, increases dissolved oxygen level, and reduces nitrogen and phosphorus to 35-60%. Publications analysis shows that the bio-plateau system mechanisms remote contaminants from wastewater. This complex system (plant-microorganisms-load) occurs aerobic and anaerobic biological processes involving filtration, adsorption, precipitation, absorption and transformation plants nutrients and other compounds (Table 2).

The role of HWP in agricultural ecosystems is versatile and multifunctional. First of all they are autotrophs and are directly involved in the organic matter formation. CO_2 recycled from the atmosphere and water, and oxygen is liberated, which water is saturated with. They bind nitrogen, phosphorus, calcium, magnesium and other elements and play an important role as biofilters at wastewater treatment from pollution, detain and weighed accumulate and organic particles [7]. The most often used facilities in bio-plateau are reed, cattail, blackamoor, pondweed and others.

Along with BTP treatment there is wastewater natural disinfection by HWP phytocenoses without chemical methods of wastewater treatment. The process is by extracting plants, algae, BTP microorganisms into the aquatic environment and other volatile substances that suppress pathogens such as helminthes eggs, Escherichia coli, and Mycobacterium tuberculosis [5].

Facilities don't stop in winter. Low temperature stops growing season, reduces microbial processes rate in the filtering layers that affects the wastewater treatment quality. But filter thickness does not freeze in winter, pollution transformation processes continue, but slow down. Bacterial degradation processes are responsible for wastewater treatment from organic matter (BODfull) is exothermic, providing heat in indigenous facility [6].

Conclusion and further research direction. One of the solutions to the problem of wastewater treatment near the Southern mining and ore-dressing complex is using of biologically engineered structures. Significant advantage of BTP at wastewater treatment is that it is an environmentally friendly method that simulates the natural processes of self-purification of water is much cheaper than traditional treatment systems, BTP method is also energy-saving technology that does not involve the use of coagulants, flocculants and ion compounds providing high efficiency of wastewater treatment.

BTP technology uses processes of sedimentation, filtration and natural self-purification of water objects based on the ability of higher water plants, aquatic flora and microorganisms to carry out destruction, transformation and accumulation of organic and mineral suspended solids, oil, heavy metals and bacterial contamination.

Using advanced technologies based on the actions of higher water plants nowadays are environmentally acceptable and economically promising direction in wastewater treatment systems. Distribution of such technologies can contribute to improving the environmental situation at localities without canalization system in Krivoy Rog.

References

1. Лейбович Л. И., Корчевский Н. В., НПФ «Рецикл», Николаев, сборник материалов IV Международной конференции "Сотрудничество для решения проблемы отходов", 2007 г., Харьков, Украина.

2. Стольберг В.Ф., Ладиженський В.Н., Спірін А.И. Біоплато - ефективна малозатратна екотехнологія очищення стічних вод // Екологія довкілля та безпеки життєдіяльності. - 2003. - № 3. - С. 32-34.

3. Трочешников Н.С., Родионов А.И., Кельцев И.В., «Техника защиты окружающей среды» Учебное пособие для ВУЗов. – М.: Химия, 1996.

4. Юрьев Б.Т. «Очистка сточных вод малых объектов». Рига, Авотс, 1983.

5. Abdallaa, K.Z. and Hammamb, G., 2014. Correlation between Biochemical Oxygen Demand and Chemical Oxygen Demand for Various Wastewater Treatment Plants in Egypt to Obtain the Biodegradability Indices. *International Journal of Sciences: Basic and Applied Research* 13 (1), 42.

6. Bansal, A.K., Mitra, A., Arora, R.P., Gupta, T. and Singhvi, B.S.M., 2007. Biological treatment of domestic wastewater for aquaculture, *J. Agri. Bio. Sci.,* 2, 6-12.

7. Duncan, M. 2003. *Domestic wastewater treatment in developing countries*, UK, Cromwell Press.

8. Khambete, A.K., Christian R.A., 2014. Ranking Sewage Treatment Plants with the Application of Fuzzy Composite Programming. *International Journal of Scientific Engineering and Technology*, 3 (2), 116-120.

9. Lloyd, B.I., Leaner, A.R., Vorkas, C.A. and Gugnesharajah, R.K., 2003. Underperformance evaluation and rehabilitation strategy for waste stabilization ponds in Mexico, *Water Science and Technology* 48 (2), 35-43.

10. Mohammed A. I., Hayder T.H., 2013. Stabilization pond for wastewater treatment. *European Scientific Journal*, 9 (14), 278

11. Nweze, N.O. and Chumboh, G.F., 2006. Physical and chemical characteristics, algal flora and coliform content of the University of Nigeria, Nsukka sewage treatment plant oxidation pond, *Nigerian Journal of Botany,* 19 (1), 103-116.

12. Prachi N.W., Sameer, U.S., 2014. Performance Evaluation of 25MLD Sewage Treatment Plant (STP) at Kalyan, *American Journal of Engineering Research* 3 (3), 310-316.

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РОЗВИТОК ГАЛУЗІ ГЕОТЕРМАЛЬНОЇ ЕНЕРГЕТИКИ В УКРАЇНІ

В результаті огляду і аналізу встановлено, що перспективною альтернативою традиційним джерелам енергії являється геотермальна енергетика. Геотермальна енергія дозволяє отримувати необхідну людству енергію завдяки теплоті надр Землі. Чим більше віддалений від центра Землі певний внутрішній шар, тим нижче його температура. Але навіть самий верхній шар Землі (біля 10- ти кілометрів) містить кількість теплоти, якої достатньо для забезпечення всіх енергетичних потреб людини. Через розлами в корі теплота проникає на поверхню планети. Потенціал геотермальної енергії величезний і невичерпний. Залишається лише навчитися використовувати те, що так великодушно дарує природа. Потенціал надр Землі дозволяє покрити усі потреби людини в енергії. Розглянуті теоретичні і практичні питання введення геотермальних станцій. Розглянуті схеми, устаткування і технології геотермальної енергетики в Україні і інших країнах.

Доступність і мінімум витрат на відбір пари й гарячої води з поверхні Землі давно цікавлять дослідників. Однак, у більшості країн теплота Землі прихована глибоко в її надрах. Розробку глибинних джерел теплоти почали порівняно недавно й практично одночасно в таких країнах як США, Японія, Ісландія, Китай, Філіппіни, Англія, Франція, ФРН. Найбільше досягнень у даному напрямку мають США та Франція. Промислове освоєння геотермальних ресурсів у світі почалося після створення й пуску в Італії в 1916 р. геотермальної електростанції потужністю 7,5 МВт із трьома турбінами фірми «Франко Тозі» потужністю по 2,5 МВт кожна. Однак широке промислове будівництво геотермальних електростанцій було розгорнуто тільки в 60-х рр. у США, Нової Зеландії, Японії, Ісландії й ін. країн.

Проблема та її зв'язок з науковими та практичними завданнями. . Джерела геотермальної енергії можуть розрізнятися залежно від способу виділення енергії (у вигляді сухої або вологої пари, підземних вод, сухих порід або магми). Використання даного виду енергії пов'язане з виконанням ряду вимог. Зокрема, наприклад, необхідно враховувати рівень твердості або мінералізації підземних вод. Теплота Землі може бути використана як джерело отримання електроенергії або використовуватись безпосередньо для опалення приміщень. Задача геотермальних станцій полягає у перетворенні геотермальної енергії в електричну. Успішна робота геотермальних станцій можлива при високих температурах підземних вод, а це означає, що встановлювати такі споруди можливо тільки в певних сейсмоактивних зонах. Найбільшою кількістю геотермальних станцій на сьогоднішній день володіють такі держави, як США, Італія, Ісландія, Японія, Кенія (лідер галузі на Африканському континенті). Існують кілька видів геотермальних станцій: станції що працюють на сухому парі (перетворення здійснюється за допомогою турбіни), станції із сепаратором і станції, робота яких заснована на застосуванні бінарного циклу (взаємодія гарячої й більш прохолодної води). Останній тип є найбільш розповсюдженим в світі, що пояснюється здатністю таких установок використовувати не занадто гарячі води (нижче 190 ºС). Остання обставина дозволяє користуватися теплотою Землі набагато більшій кількості країн [1].

До недоліків геотермальної енергії слід віднести обмеженість можливостей отримувати значні обсяги енергії Землі країнами світу, що розташовані у не вулканічних районах планети.