Ministry of Education and Science of Ukraine
Black Sea Universities Network

ODESA NATIONAL UNIVERSITY OF TECHNOLOGY

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2022

PROCEEDINGS

ODESA, ONUT 2022

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Proceedings of International Competition of Student Scientific Works «Black Sea Science 2022» contain the works of winners of the competition.

The author of the work is responsible for the accuracy of the information.

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INTRODUCTION

International Competition of Student Scientific Works “Black Sea Science” has been held annually since 2018 at the initiative of Odesa National University of Technology (formerly Odesa National Academy of Food Technologies) with the support of the Ministry of Education and Science of Ukraine. It has been supported by Black Sea Universities Network (the Association of 110 higher education institutions from 12 countries of the Black Sea Region) since 2019, and by Iseki-FOOD Association (European Integrating Food Science and Engineering Knowledge into the Food Chain Association) since 2020.

The goal of the competition is to expand international relations and attract students to research activities. It is held in the following fields:

- Food science and technologies
- Economics and administration
- Information technologies, automation and robotics
- Power engineering and energy efficiency
- Ecology and environmental protection

The jury includes both Ukrainian and foreign scientists. In the 4 years that the competition has been held, the jury included scientists from universities of 24 countries: Angola, Azerbaijan, Benin, Bulgaria, China, Czech Republic, France, Georgia, Germany, Greece, Israel, Italy, Kazakhstan, Latvia, Lithuania, Moldova, Pakistan, Poland, Romania, Serbia, Slovakia, Switzerland, Turkey, USA.

At the same time, every year the geography has expanded and the number of foreign jury members has increased: from 46 jury members representing 25 universities from 12 countries in 2018, to 73 jury members of the 46 universities from 19 countries in 2022.

More than a thousand student research papers have been submitted to the competition from both Ukrainian and foreign institutions from 25 countries: China, Poland, Mexico, USA, France, Greece, Germany, Canada, Costa Rica, Brazil, India, Pakistan, Israel, Macedonia, Lithuania, Latvia, Slovakia, Romania, Kyrgyzstan, Kazakhstan, Bulgaria, Moldova, Georgia, Turkey, Serbia.

The interest of foreign students in the competition grew every year. In 2018, the students representing 15 institutions from 7 countries have submitted 33 works. In 2021 the number of submitted works increased to 73, authored by the students of 40 institutions from 18 countries.

The competition is held in two stages. In the first stage, student research papers are reviewed by members of the jury who are experts in the relevant fields. In the second stage of the competition, the winners of the first stage have the opportunity to present their work to a wide audience in person or online.

All participants of the competition and their scientific supervisors are awarded appropriate certificates, and the scientific works of the winners are included in the electronic proceedings of the competition. Every year the competition receives a large number of positive responses from Ukrainian and foreign colleagues with the desire to participate in the coming years.

5. ECOLOGY AND ENVIRONMENTAL PROTECTION

BIOLOGICAL TREATMENT OF LEACHATE LANDFILL FILTRATES

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Abstract: Actuality of the work. *Existing landfills of Ukraine today turned into powerful sources of environmental danger. The problem is specifically hectic for Ukraine since there are many landfills from Municipal solid wastes (MSW) in Ukraine that have been in a need for closing for a long time already. Same problem exists in other countries. For solution of this problem it is suggested a two-stage purification for infiltrates on landfills in Ukraine and reduction of environmental danger from their accumulation (that is observed on the example of Hrybovytske landfill).*

Aim and tasks of the work. *Aim of the work is to increase a level of environmental safety of hydrosphere with the help of two-stage purification of infiltrates from landfills in aerobic lagoons and municipal sewerage pollution control facilities (PCF).*

For achievement of the set aim the following tasks should be solved:

-to conduct analysis of environmental danger sources of hydrosphere on the territory of Hrybovytske landfill;

-to study process of biological purification of infiltrates in aerobic lagoon in static regime;

-to set optimum conditions for biological purification of infiltrates in aerobic lagoon in dynamic regime;

-to set technological peculiarities of implementing a stage of pretreatment of infiltrates on landfills in aerobic lagoon;

-to set stability of parameters for tertiary treatment of infiltrates on municipal PCF;

Scientific part of the work lays in*: 1. Setting impact of parameters in implementation process (time of delay of infiltrates in aerobic lagoon, temperature, periodicity of it) on effectiveness of infiltrates` purification in aerobic lagoon that would give opportunity to optimize purification process.*

2. Studied peculiarities of biocenosis development of aerobic lagoon that enabled to prognosticate a development of biological process of infiltrates` purification.

Result of the work is: *setting optimum conditions for implementation of two-stage technology of landfills infiltrates purification.*

INTRODUCTION

Existing landfills in Ukraine, processes of creation and functioning of which is highly resembling for all the objects, today turned into powerful sources of environmental danger. Problems of infiltrates purification of SMW exist during all projection period, exploitation period, and closing of the objects. It is worth mentioning that most of storage places for MSW in Ukraine are basically landfills, not polygons. Unlike SMW landfills, polygons are engineering buildings that are equipped with protection anti-filtration display, collection systems and utilization of filtrates and biogas, system of technical and biological recultivation of cards filled with wastes,

harvesting system and drainage of conditionally clean atmospheric waters. In most cases all these systems (or the majority of them) on the MSW collection places in Ukraine don't exist. The problem is choosing the system of infiltrates purification at the stage of MSW landfill closing, for majority of which uncontrolled flow of infiltrates caused accumulation of their volumes in pounds-accumulators.

For purification of infiltrates before the beginning of landfill recultivation perspective is two-stage purification of landfill infiltrates in aerobic lagoons and municipal PCF, though enough reasonable scientific and practical recommendations for two-stage purification application under different conditions of different composition of infiltrates purification are absent. This has led to a need to conduct scientific research aiming setting optimum conditions for two-stage purification for landfills infiltrates in Ukraine and environmental danger elimination from their accumulation.

1. Environmental danger of hydrosphere pollution caused by filtrates of MSW landfills and its assessment

Polygons of MSW – sources of chemical and biological pollution of the environment. Specifically dangerous is impact from MSW landfills on the surface and underground water that lays within the impact of these objects. MSW polygons are inseparably connected with environmental objects and influence on its compounds condition: soils, underground and surface water sources, atmosphere air, biotes. Continued accumulation of municipal wastes on landfills causes unpredictable physical and chemical and biochemical processes in liquid, solid and gas state.

MSW dumps are powerful sources of environmental pollution – atmosphere, hydrosphere, soils. Because of variety of wastes that are directed to landfills and polygons, to assess chemical composition of wastes is highly difficult. On bumps with a depth of 1,5–2 m and more there always appears grey-black coloured with BOD_5 ranging between 500 – 5000. mg/dm^3 . It is so called infiltrate, very toxic substance that continuously leaks from wastes thickness. Toxicity of infiltrate doesn't reduce even after its dissolution for 100 times. As a rule, these dumps aren't equipped with anti-filtration screens, collection systems of infiltrate that creates in dump body resulting from atmospheric falls and processes of organic compounds decomposition. Soil and surface waters that leak through land covering, capture dissolved and suspended solid substances and products of biological decomposition, that's exactly why MSW leaching solutions contain different chemical elements and compounds. Volume of filtrate that creates during a year depending on climate conditions from 1 ha of waste body, reaches generally from 2000 to 4000 m^3.

1.1.Infiltrate purification technology

The most popular technologies in Ukraine are the following:

- Reverse osmosis technology;
- Technology of chemical and biological oxidation;
- Infiltrate knotting technology;
- Technology of biological purification in anaerobic and aerobic medium.

Aerobic methods of biological purification of filtrates have row of undeniable advantages over anaerobic: they are flexible in using, fast include in stationary regime of work, fast accommodate to changeable composition and expanses of filtrates. Aerobic reactors are far more simpler in construction and far more cheaper than anaerobic, they are also much easier automatized and easier in exploitation.

From analysis of existing natural studies it is possible to make conclusion, that purification of infiltrates in aerobic lagoon (or simultaneously connected lagoons) is simply, low-budget and enough efficient method of pretreatment of infiltrates.

2.Characteristic of Hrybovytske (Lviv) landfill

The dump has started to exist since year 1969, according to different information sources its space reaches from 33,3 ha to 45,3 ha, accumulated wastes reach maximum height of 45 m.

The body of MSW Hrybovytske landfill reaches around 12 – 15 mln. tons of wastes. Specifically hazardous effect on the environment around MSW Hrybovytske landfill territory have four pound-accumulators of acid flux tars (one of them is filled with wastes). General space of flux tars reaches around 5 ha. Level of infiltrate danger - «extremely hazardous», and danger class of infiltrate on MSW Lviv landfill reaches 1.

3.Methodology of laboratory experiments of infiltrates` aeration and methodology for research of infiltrate tertiary treatment stage on municipal PCF

3.1.Study of the aerobic purification was conducted at plant (Ill. 2.1).

The plant contained from 5-litter bulb, that with volume of 4 l was filled with infiltrate. Infiltrate for studies was chosen from pound-accumulator of Lviv MSW For aeration the air was supplied to bulb with the help of laboratory compressor. With the help of regulation compressor, set on air flow tube, it was regulated air expanses on aeration and supported constant significance of this expanse throughout the whole experimental time.

Ill. 3.1. Scheme of experimental plant for infiltrate aerobic purification.

In bulb there was set an aquarium aerator, via which division of air took place in bulb volume. After some periods of time from bulb was taken probes, that were analysed on ammonium nitrogen content, COD, it was set also a content of dissolved oxygen and hydrogen indicator pH.

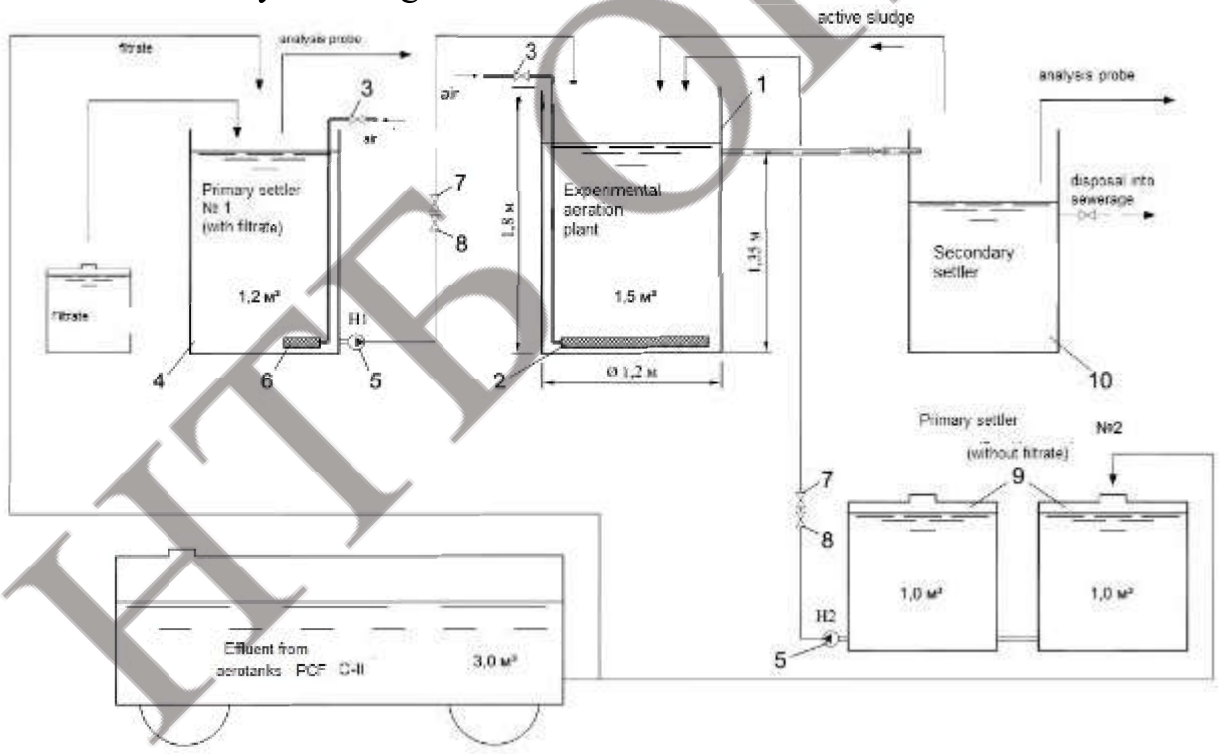
Experimental work was conducted in two stages.

At first stage (static) was set alteration of COD, concentrations of ammonium nitrogen, pH and concentration of dissolved oxygen under conditions of continuous aeration without allotment of pretreated infiltrate and accordingly without addition into volume `fresh`, untreated infiltrate.

At second stage (dynamic) that was conducted after obtaining maximum possible level of purification under static regime, it was modeled continuous regime of purification, that is planned to be implemented at industrial pollution control facility. Once in 24 hours from bulk it was taken certain amount of infiltrate and was poured same amount of `fresh` unpurified infiltrate. For certain proportion significance of the sample the researches were conducted for obtaining constant concentrations of ammonium nitrogen and COD. After that, the daily volume of purified and `fresh` infiltrate was substituted, that accordingly was collected and poured into aeration plant, and it was studied a process of aerobic purification in dynamic regime for another time significance of infiltrate delay in aeration zone. Once in a day an infiltrate sample from bulk for analysis and sample for addition of infiltrate were taken.

3.2.Methodology of tertiary infiltrate treatment research at PCF

Studies on infiltrates` impact on process of biological purification at sewerage pollution control facilities of Lviv city were conducted at experimental plant, displayed at Illustration 2.2, that imitated sewerage pollution control facilities. The studies were held in static and dynamic regimes.



Ill. 3.2.

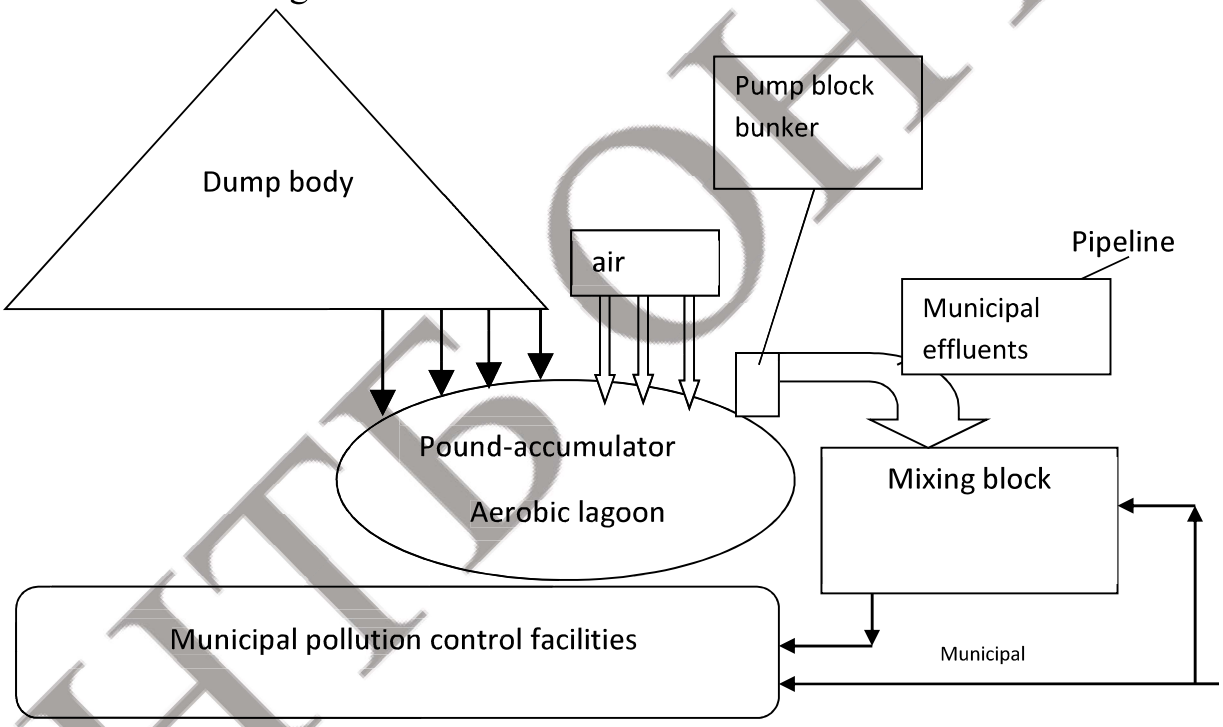
For experiments in static regime for research place a mixture of effluents with active sludge was taken. Infiltrate in quantity of 1 m^3 was selected from pound-accumulator №5 in MSW Hrybovytske landfill. In experimental aeration plant was poured mixture of effluents and active sludge and was added calculated quantity for obtaining mixtures, that met the following dissolving criteria: 10; 500; 1000; 1250; 1500. In reactor it was added mixture of effluents with active sludge till obtaining

general volume in 1,64 m^3. After that samples were taken for chemical experiments and the plant was launched. Every study cycle in static regime lasted 6 hours. After finishing of air supply a sample was taken for conducting chemical experiments.

Experiments in dynamic regime were conducted at the same plant (Ill.2.2.) The plant contained primary settlers: primary model settler for mixture of effluents with infiltrate and primary model settler for effluents without infiltrate. During 8 daily experiments the mixture from effluents and infiltrate as equally carried to aeration plant 1. Regulations of expanses were carried with the help of circulation pump and valve. Homogeneity of the mixture was obtained with the help of aerator. After 8 hours of mixture supply from effluents with infiltrate it was modeled working process of aerotank during 16 hours without adding infiltrate.

4.General strategy for two-stage cultivation of landfill infiltrates

Analyzing research data it is recommended principal scheme for implementation of landfill infiltrates pretreatment technology that is illustrated in Ill..5.2. According to this scheme, infiltrates are accumulated in pound-accumulator that simultaneously serves as aerobic lagoon.



Ill.3.3. Principal scheme of two-stage landfill infiltrate purification in aerobic lagoons and at municipal pollution control facilities.

For this it is equipped with aeration system. Pound-accumulator is being screened with protective display by using well known technologies. In aerobic lagoon biological aerobic oxidation is taking place of organic contaminants and of ammonium nitrogen. Constant inflow is being realized and harvesting of infiltrates under conditions of supplement with necessary period of infiltrate residence in reactor. Infiltrate collection is being done with the help of pump station throughout set pipeline «landfill – municipal PCF» infiltrate is transferred into mixing block PCF where at given proportion it is mixed with municipal effluents and in mixture is directed to tertiary treatment at municipal PCF. For every particular case for technology implementation

it is necessary to make balance calculation. In ratio of Lviv PCF it is set the following input of infiltrates: 1) infiltrate disposal into system of city sewerage of Lviv is necessary to conduct from 09 am to 5 pm with gradual productivity increase from 10 m^3/hour to 25 m^3/hour; 2) it is necessary to cease disposal of infiltrate under nonfavourable climate conditions, particularly: under exceed of temperature of effluents in aerotanks КОС-II over 20 ^oC and its reduction under 10 ^oC.

Concerning two-stage scheme for infiltrate purification application at other objects, then in every particular case it is necessary to make additional calculations and based on their results to set optimum regimes for infiltration pumping.

CONCLUSION

An identification of environmental danger sources was conducted on the impact territory of Hrabovytske landfill. It was set, that in the hazardous impact zone of Hrabovytske landfill it is possible to distinguish three potential sources of environmental danger: stored MSW, lakes from crude oil recycling and industrial activity of the population. It is impossible to concretize an impact from every form of the source, yet it is possible to judge which type of contamination is causing each from the sources.

Ukrainian landfills create consistent environmental danger in their impact zone because of absence of protection anti-filtration screen, collection system and utilization of filtrates and dump gas, plants system of physical and biological recultivation of cards filled with wastes, harvesting systems and drainage of conditionally clean atmospheric waters. Analysis of possible technologies for purification of accumulated infiltrates has shown perspective to apply technologies for biological purification of infiltrates in aerobic lagoons.

Suggested two-stage purification scheme of landfill infiltrates enables to purify infiltrates effectively with primary purification under conditions of aerobic lagoon on the territory of landfill, transporting of infiltrate with the help of pipeline «landfill – municipal PCF», dissolving it with municipal sewerage effluents and pretreatment on municipal PCF. To apply the two-stage infiltrate purification scheme on proper objects, in every concrete case it is necessary to make additional equations and calculations and on their result bases to set optimum regimes of pumping over the infiltrate.

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