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[1]**Oksana O. Vovk,** Assoc. Prof.
[2]**Angela E. Gay,** Assoc. Prof.
[3]**Anna V. Yakovleva,** Postgraduate

EM-TECHNOLOGY APPLICATION FOR MUNICIPAL WASTEWATERS PURIFICATION FROM BIOLOGICAL POLLUTANTS

National Aviation University
[1,2]E-mail: img@nau.edu.ua
[3]E-mail: pinchuk_anya@ukr.net

Abstract. *This article is devoted to the problem of municipal waste waters purification. The present day situation with waste water treatment facilities in Ukraine, existed methods of waste waters purification and search for new ones are described. Much attention is paid to such kind of pollutants as microbiological and bacterial. A comparatively new method of sewage waters purification from biological contaminants and possibilities to apply this method in Ukraine is presented in the article.*

Keywords*:* biological pollutants, disinfection, effective microorganisms, EM-technology, treatment facilities, wastewaters.

Introduction

Nowadays in Ukraine almost all sewage water treatment constructions have became inefficient because their infrastructure is old. Volume of drains which has increased due to the fast growth of urban population number exceeds designed capacities of these constructions. As a result many treatment facilities have problems with unpleasant odors and low quality of dumped drains. It generates environmental problems that are widely discusses by the population and the authorities as well. Traditionally, problems connected with municipal wastewaters treatment systems require significant capital investments for their solution. In connection with high cost of traditional engineering decisions there is a need in search of new technologies, which would allow solving these problems within the limits of an existing infrastructure and with the minimum money investments.

Considering the problem of sewage waters treatment we should say that the city waste water pollution leads to the great number of problems connected with a citizens health and with the environment itself.

Analysis of researches and publications

The wastewaters are waters used for household, industrial or other needs and polluted with various admixtures that change their initial chemical composition and physical properties. Depending on the way of formation and composition the wastewaters are divided into three main categories: municipal, industrial and atmospheric. The municipal wastewaters (coming from toilets, bathrooms, kitchens, hospitals, offices, etc) are formed in a result of everyday human activity. The sewage waters contain admixtures of mineral and organic origin. A special form of the municipal wastewaters admixtures is microorganisms. Sometimes they may contain pathogenic forms of microorganisms (bacteria and viruses) [1].

Methods used for purification of the municipal and industrial wastewaters may be divided into three groups: mechanical, physical-chemical and biological. Complexes of treatment facilities usually include mechanical purification facilities. Depending on the purification degree needed they may be added with physical-chemical or biological treatment facilities. When purification requirements are quite high treatment facilities may include methods of advanced purification. Purified wastewaters should be disinfected before the drain into water body. Sludge that is formed on every stage of purification process comes to facilities for sludge treatment for further processing. The purified wastewaters may come into cycling systems of industrial enterprises water supply, for agricultural needs, or simply drained into water bodies. The processed sludge may be utilized, destructed or stored. Mechanical purification is used for extraction of insoluble mineral and organic admixtures from the sewage. This is a method of primary purification, and it is used to prepare the wastewaters for biological and physical-chemical methods of purification.

As a result of mechanical purification, the content of the suspended particles decreases up to 90 % and organic substances decrease up to 20 %. The mechanical treatment facilities include grids, various kinds of catchers, sediment bowls, sand and oil separators, filters etc. Chemical and physical-chemical methods of purification play a very important role during industrial wastewaters treatment. They may be used in conjunction with biological and mechanical methods [2]. The most spread physical-chemical methods of purification are: chemical addition, clarification, ion exchange, disinfection, UV-radiation, electrodialysis, ph-adjustment, scavenging, etc. Various kinds and methods of sewage treatment are used simultaneously to reach higher level of wastewaters treatment [3].

Purpose

Nowadays one the most important ecological problems of Ukrainian cities is the state of municipal sewage waters treatment systems. Almost in all cities of Ukraine wastewaters treatment facilities are old and need general reconstruction. The majority of facilities for municipal waste waters treatment are overcharged. Their capacity is in several times lower than it is required. About a half of municipal sewage waters, which are damped into the water objects, is purified insufficiently, about 15% from this volume is damped without any purification.

As it is known, the parameters of portable water used in Kiev are unsatisfactory. Moreover, the significant amount of waste water pollutants is of microbiological and bacterial character. So, the necessity in improvement of sewage wastewaters treatment process seems to be obvious. In present days it is necessary to develop and apply optimal complex approaches to water supply ecologization. In our research we aimed on investigation mainly microbiological and bacterial water contamination and develop optimal method to treat waste waters from this kind of pollutants.

Biological wastewater treatment

The biological wastewater treatment is usually used for secondary clearing after appliance of filtration and other methods of water purification. There are two widely used types of biological wastewater treatment: those that include mechanical means to create contact between wastewater, cells and oxygen, and those that don’t.

Treatment with application of mechanical means:

1. Activated sludge.
2. Trickling filter.
3. Biological contactor.

Treatment without application of mechanical means:

The wastewater is made by gravity force to flow through a specially constructed wetland. There, the water is brought into close contact with vegetation (ex. reeds), which acts as a biological filter to the water. The organic material in the wastewater is used as nutrient by the plants. The advantages and disadvantages of biological methods are pretty much common.

The advantages of biological wastewater treatment are:

1. Highly efficient method.
2. Requires little land area.
3. Applicable to small communities and to big cities.

The disadvantages of biological wastewater treatment are:

1. High cost.
2. Requires sludge disposal area.
3. Requires technically skilled manpower for operation and maintenance.

Effective microorganisms technology

Effective but not widely used Effective Microorganisms (EM)-method was chosen in our investigation thanks to its high effectiveness, relatively low cost, simplicity of application and ability to use in sewage treatment systems of big cities.

As a whole EM represent a liquid with pH = 3,5 or below. They are created by mixing various groups naturally living in the nature useful, not pathogenic, aerobic and facultative anaerobic microorganisms consisting in basic from phototrophic and the lactic bacteria and yeast. EM contain a plenty of lactic bacteria (Lactobacillus and Pedicoccus) in concentration 1×10^5 CFU/mL, yeast (Sacharomyces) in concentration 2×10^6 CFU/mL and a small amount of photosynthesizing bacteria, actinomycetes and other microorganic cultures [3].

According to the patent registered in the USA 5.591.634 EM comprises at least on one culture actinomycetes, phototrophic bacteria, lactic bacteria, mold fungi and yeast. Actinomycetes are presented to one of these cultures: Streptomyces albus, Streptoverticilliu baldaccii, Nocardia asteroides, Micromonospora chalcea, or Rhodococcus

rhodochrous. The culture phototrophic bacteria can be one of the following: Rhodopseudomonas sphaeroides, Rhodospirillum rubrum, Chromatium okenii, or Chlorobium limicola. One of such cultures can represent lactic bacteria: Lactobacillus bulgaricus, Propionibacterium freudenreichii, Pediococcus halophilus, Streptococcus lactis, or Streptococcus faecalis. Mold fungi are presented at list one of following cultures: Lactobacillus bulgaricus, Propionibacterium freudenreichii, Pediococcus halophilus, Streptococcus lactis, or Streptococcus faecalis. Yeast should be presented even to one of cultures Saccharomyces cerevisiae, Saccharomyces lactis, or Candida utili [4].

The main in EM are: strains lactic bacteria Lactobacillus plantarum (ACTCC8014), Lactobacillus casei (ACTCC7469), and Streptococcus lactis (IFO12007), strains phototrophic bacteria Rhodopseudomonas palustris (ACTCC17001), and Rhodobacter sphaeroides (ACTCC17023), strains yeast Saccharomyces cerevisiae (IFO0203), and Candida utilis (IFO0619), strains fungi Streptomyces albus (ATCC3004), Streptomyces griseus (IFO3358), Aspergillus oryzae (IFO5770), and Mucor hiemalis (IFO8567). Other microorganisms naturally living in the nature, capable to coexist with the above-stated microorganisms containing in a liquid preparation with pH = 3,5, can be added during manufacture EM. The density of the above-stated microbiological cultures in EM which there it is totaled nearby 80, can change within the limits of from 10^4 up to 10^8 CFU/ml. The specified cultures represent group of useful microorganisms which can coexist in the same conditions.

Effective microorganisms should be add in certain concentration to the sewage water depending on the level of pollution in order to make the treatment process most effective. First of all the EM inoculants should be add in the biggest collecting points in the city and then in one or two points on the water purification station before the water treatment equipment. It should be add by portions not constantly, those portions should depend on peaks of sewage intake [4].

The equipment, which combines natural physical methods and biological activity of microorganisms is applied during sewage processing. The microbes used in the clearing equipment are represented by cultures living in sewage. However, microorganisms, which naturally live in drains, are not always possible to provide the required quality of treated drains. Therefore it is possible to assume, that the method of specific microbic cultures introduction into sewage may increase efficiency and productivity of existing treatment systems [5].

The advantages of microbic cultures introduction into wastewater treatment process are:

1. Highly efficient method.
2. Comparatively low cost.
3. Simplicity in use.
4. Applicable to small communities and to big cities.
5. Natural method of sewage treatment.
6. Low operational expenses.
7. Ecological compatibility and safety.

Speaking about disadvantages of microbic cultures introduction into wastewater treatment process we can mention only insignificant increase of sulfates content.

EM-technology has being successfully applied in numerous countries for about 20 years. Analysis of this experience shows that introduction of effective microorganisms into sewage treatment process reduces unpleasant smells, improves quality of treated waters and waste water mud (WWM), significantly reduces quantity formed WWM, increases the level of colibacillus suppression, and decrease sulfides content [6].

Conclusions

The city waste water pollution leads to the great number of problems connected with a citizens health and with the environment itself. In Kiev the household water processing at «Bortnichy» station of aeration is not satisfactory at the moment. The sanitary and hygienic indexes of the clarified water, which is dumped into the Dnieper river exceed all limits and norms. The allowable concentration of the pollutants is provided due to the multiple dilutions with the fresh water from the river. The amount of sewage, which is formed during treatment process, has already overfilled the existed sludge fields. The possible dam breakthrough may cause unpredictable problems for the environment in the nearest future.

As it was mentioned before a significant percentage of pollutants in municipal wastewaters is of microbiological origin. That is why our research is devoted to investigation of new methods and technologies for water purification from biological pollutants. Analyzing the principle of EM-technology application in other countries we came to conclusion that it can also be used in our country.

Implementation of EM may show such results: decrease of primary sludge production and dry matter quantity, reduction of nitrogen concentration in clarified water, removal of the fetid smell problems due to the reduction of ammonia concentration.

Considering all abovementioned we suppose that EM-technology implementation into the municipal wastewaters treatment systems may be beneficial not only from the ecological but also from the economical point of view.

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