STRATEGY FOR COMPLEX ENVIRONMENT PROTECTION FROM INFLUENCE OF LANDFILLS OF MUNICIPAL SOLID WASTE LANDFILLS

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At the present stage of scientific and technological progress, especially after independence in Ukraine, the largest source of pollution are landfills of municipal solid waste (MSW). For all the years of the independent state of Ukraine any solid waste disposal company for household and semi garbage was not built and the procedure of its separate collection has not become widespread.

Consequently, we reduced waste management to the garbage disposal in landfills. The vast majority of them operates in overloaded mode, which is violation of the design parameters on the volume of wastes. However, due to lack of necessary structures and mechanisms, the disposal technology is violating regulatory requirements, which in turn leads to environmental pollution.

Therefore considerable efforts to prevent pollution of the hydrosphere by drainage waters from MSW landfills by arranging cutoff screens that prevent their filtration in aquifers using low-cost and effective components (natural clay adsorbents and phosphogypsum). The introduction of effective technologies for collection and treatment of MSW landfills drainage waters will increase the level of environmental safety in the places of collection of solid waste and provide environmental protection in their area of influence.

Keywords: landfills, mineral clay, phosphogypsum, sorbents, filter.

INTRODUCTION

Provision of human vital functions is connected to appearance of enormous amount of various municipal solid waste (MSW). This contributes to a significant growth of resources consumption, goods worldwide in the past decades. Ecological studies carried out in many countries in the last decade have shown that the increasing destructive effect of anthropogenic factors on the environment led it to the brink of crisis.

The rate of formation of solid waste varies, reflecting the state of supply of goods and at the same time, it is significantly dependent on local conditions. Paper and cardboard are the major part of the waste, the second largest category - the so-called organic, including food waste, metal, glass and plastic up to 7-9% of the total waste.

Quantity of municipal waste in Ukraine increased and its part, especially in large cities, is approaching to the composition of MSW in Western countries with a relatively large proportion of waste paper and plastic.

Lviv region is in the list of 4 regions of Ukraine, which are characterized by the highest rates of accumulation of waste, and the city plays in this situation not the least important role. At present there are 51 solid waste landfills and illegal dumps in the amount of 521 units. Most landfills operates in overloaded mode, which is violation of design parameters on the volume of waste accumulation.

Household wastes are stored in natural relief formations - gullies, ravines, river valleys. This creates an environmental hazard as wastewater rich in contaminants, falls into the water.

Consequently, waste management in the Lviv region is reduced to dumping them in landfills. In landfills such harmful gases are produced as methane, hydrogen sulfide, carbon dioxide and carbon monoxide, and others. Another product of the decay is filtrate, contaminating soil and groundwater.

Atmospheric precipitation (rain, snow) under the action of sunlight leads to the formation of landfills contaminated wastewater that enters the soil and water in various horizons, create a constant uncontrollable threat to the environment. For liquidation of such sources will be needed certain material costs, financial and intellectual nature.

Penetrating into the soil and groundwater, surface and ground water, the filtrate pollutes them, also causing contamination of drinking water, such as wells, ponds and rivers. In the long-term waste stored various bacteria that cause typhoid, dysentery, cholera, tuberculosis and other dangerous diseases. Penetration of drainage water into underground horizons may lead to the spread of these microorganisms over wide areas.

During the recent years the problem of Lviv city dump area of 33.3 hectares, located in a natural hollow near the village Mali Hrybovychi Zhovkivskyi area remains unsolved. It does not comply with the environmental requirements, threatens the environment and human health.

Protection of soil and groundwater is done by placing a special screen cutoff around the bottom and sides of the polygon, systems interception, diversion and treatment of leachate, as well as of observation wells to monitor groundwater quality.

Antifiltration screen of the landfill - is a layer of clay, which is according to the European standards of filtration rate by no more than 10^{-9} m/s. We propose to make a cutoff screen using mineral clay and waste of phosphoric acid - phosphogypsum in a certain proportion.

METHODOLOGY

Experiments for analysing the filtration properties of the selected mineral clays consists of determining filtration rate in the experimental column filled with mineral clay.

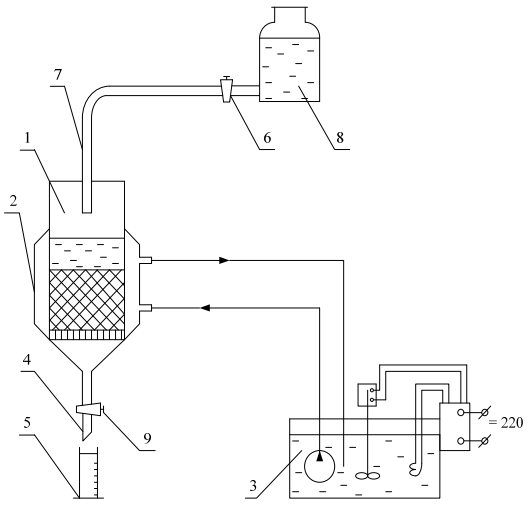


Figure 1. The experimental setup: 1 - filtration column, 2 - the heating "shirt", 3 - thermostat, 4 - pipeline to drain leachate, 5 - receiver filtrate, 6 - control valve, 7 - pipeline to supply water column, 8 - lifting capacity, 9 - locking valve.

RESULTS AND DISCUSSION

Experimental study of filtration properties of bentonite and palygorskite were conducted in both not stabilized (not compressed) and in stabilized (compressed) states in order to explain how the layer of mineral clay will behave in the early operation of the landfill and after some time of using it.

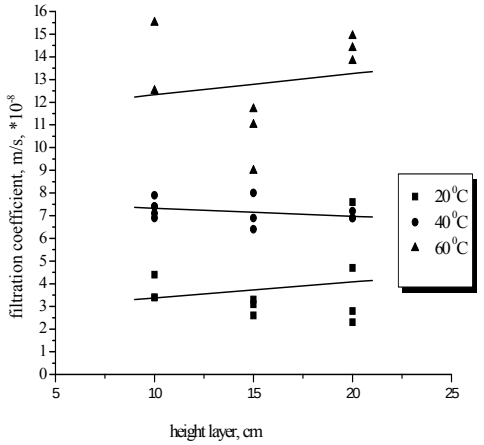


Figure 2. Dependence of the filtration coefficient layer of bentonite on its height (h) in the column in different temperatures of the process (t).

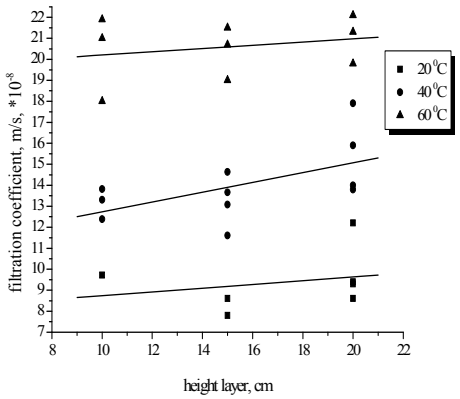


Figure 3. Dependence of the filtration coefficient layer palygorskite on its height (h) in the column in different temperatures of the process (t).

To investigate the behavior of cutoff clay layers during long-term operation on the polygon, the following series of experiments were carried out with the stabilized layer of clay.

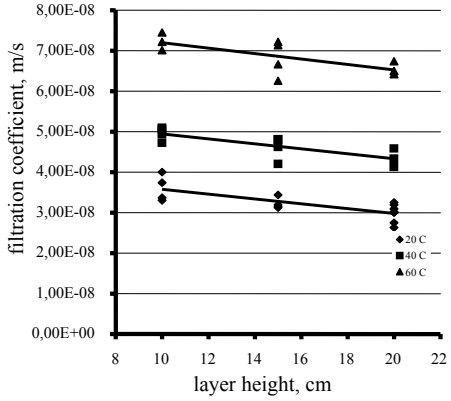


Figure 4. Dependence of the filtration coefficient layer of bentonite on its height (h) in the column in different temperatures of the process (t).

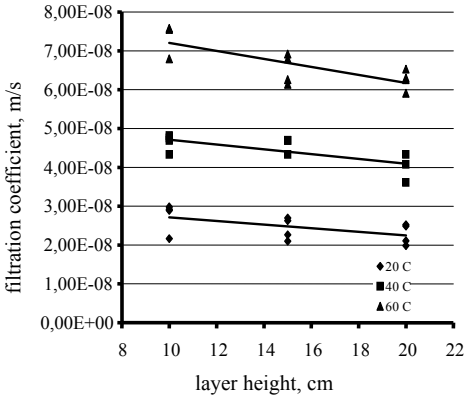


Figure 5. Dependence of the filtration coefficient layer palygorskite on its height (h) in the column in different temperatures of the process (t).

The experimental results showed (Fig. 2 and Fig. 3) that the layer of clay is not stabilized, the rate of drainage water filtration coefficient is slightly depending on the height of the layer of mineral clay and bentonite filtration rate is less than palygorskite.

However, the results of experiments with stabilized clay layer showed that the height of the filtering layer has a certain influence on the filtration coefficient (K) clay because the thickness of the filter layer increases its hydraulic resistance so filtering coefficient decreases. Stabilization of the clay layer improves the antifiltration properties of clay minerals (decreasing filtration rate), which is confirmed by experimental results.

This explained by the nature of clay, which is used, and its dispersion. It follows that, given the basic characteristics of the mineral clay, which is proposed to use as a antifiltration screen - their filtration properties, better organize antifiltration screen by palygorskite.

According to the experiments described above, even stabilized antifiltration screen with mineral clay (as bentonite, and palygorskite) does not provide a standardized filtration coefficient ($K = 10^{-9}$ m / s). In this regard, we have conducted a study to improve the efficiency of antifiltration screen (reducing its filtration rate) by adding to the mineral clay (palygorskite) as a filler finely dispersed solid waste production phosphoric acid - phosphogypsum, which is in large quantities is in heaps of the Lviv region.

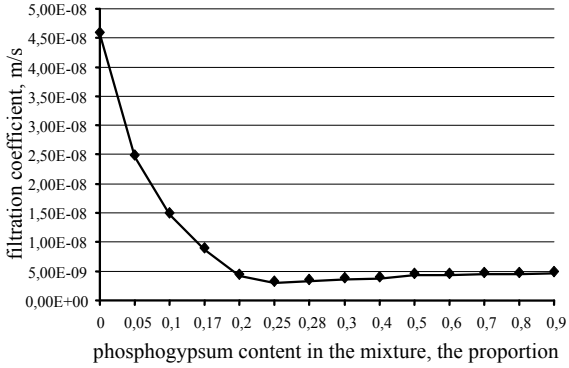


Figure. 6. Dependence of filtration coefficient on the content of phosphogypsum in the mixture

The choice of palygorskite as the basis for a screen test site we also confirmed by experiments on its sorption properties.

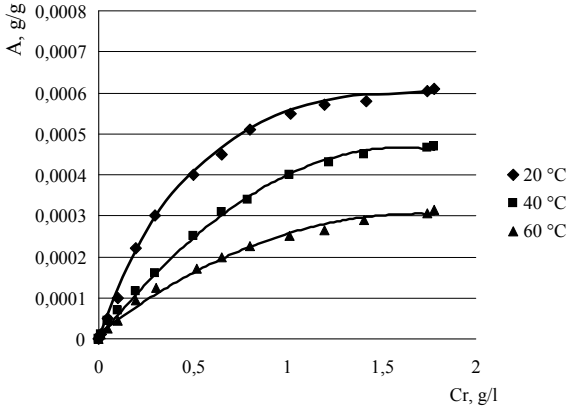


Figure. 7. Adsorption isotherms of ammonium ions bentonite at temperatures 20, 40 and 60 ºC.

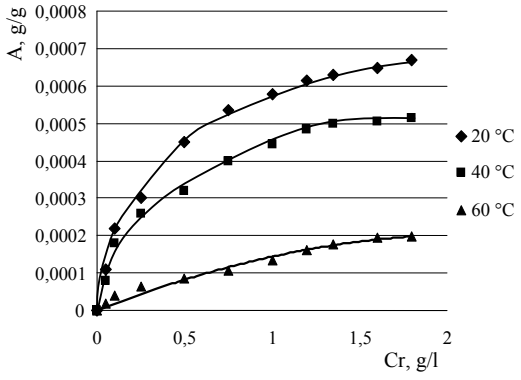


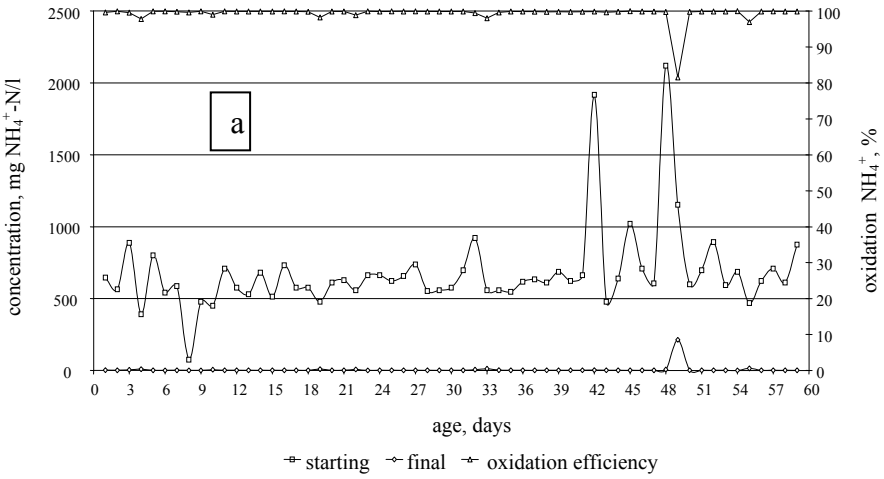
Figure. 8. Adsorption isotherms of ammonium ions palygorskite at temperatures 20, 40 and 60 ºC.

Taking into account the sorption capacity of clays by ammonium ions, it can be concluded about adsorption advantages of palygorskite and using it as a substrate is landfill, which confirms the correctness of our choice, made by its filtration properties.

As general for infiltrations of all existent dumps of TIIB is pollution of them by ammonia nitrogen of considerable concentrations and organic compounds, the necessary constituent of all options of cleaning of infiltrations of dumps of TIIB is the stage of biological treatment.

It passed in two stages in biomembrane reactors A and B, that differed in composition of drainage water, that was fed to them.

Fig. 9 shows the experimental results of biological purification of drainage water for the entire time course experiments, and the percentage of the initial amount of ammonium nitrogen to ammonia nitrogen in the purified water.



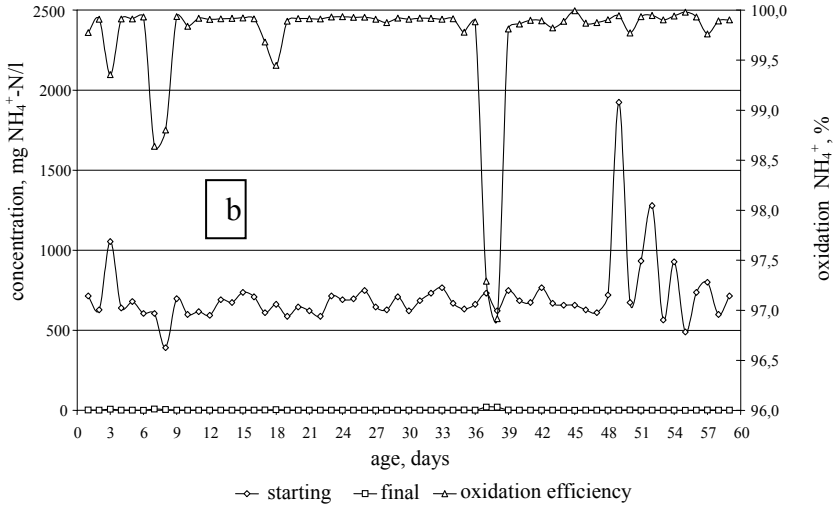


Figure. 9. a, b. The course of oxidation of ammonia nitrogen during the whole period of the experiments in biomembranne reactors: a - reactor A, b - reactor B.

The experimental results make it possible to assert that the use of biological treatment of landfill drainage water is an effective method, since the oxidation of ammonia nitrogen in this case is about 99%.

CONCLUSIONS

Thus for creation the antifiltration screens should be used available and inexpensive materials (development can be used for creation of local protective screens for existing MSW landfills, and also for the new MSW landfills). These materials are natural clay sorbents that have the ability to grow in volume during hydration, thus providing reliable antifiltration screen and phosphogypsum, which is a large waste of phosphate ore which requires disposal, as a part of the screen antifiltration, due to dispersion and properties binder creates an additional antifiltration resistance.

Using all of these measures will make it possible to reduce the environmental hazards of pollution of the hydrosphere landfill drainage water.

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