Constructions for the Protection of Underground Water against Pollution, in Warehouse Deposit Areas

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Abstract. Groundwater pollution can occur from the emission of a pollutant through the soil, which then interacts at biotic and abiotic levels entering the food chain and reaching directly or indirectly to humans. Such a pollutant can be represented by the deposition of household residues. The water infiltrated by these deposits and then by their sole and flanks is an important source of pollution of groundwater with the most serious effects. By virtue of this concept, for the protection of the groundwater in the area of household waste deposits, it is proposed to adopt a “clean technology” for the implementation of complex deposition improvements, which will prevent the appearance of pollutants, initially in the most important urban areas, and for the future generalization of these improvements in other localities. The essential elements of this complex arrangement of household waste depots refer to: the sealing system of the base layer which integrates a safety gallery from which checks and repairs are made; deep sealing walls that do not allow the circulation of the groundwater located below the deposit site so that in case of infiltration of some polluting substances in this area, their area of influence is limited; the sealing system that limits the flow of water infiltrating through the deposits and avoids air pollution with substances resulting from the anaerobic decomposition of household waste. Above the combined sealing system, it realizes a system of streams of granular material of ϕ 16-32 mm, casts the distance of about 20 m, to capture the infiltration water and to conduct it by gravitational flow spreading collector. For this purpose, the streams will have a minimum slope of 1%.

1. Introduction
Groundwater pollution can occur from the emission of a pollutant through the soil, which then interacts at biotic and abiotic levels entering the food chain and reaching directly or indirectly to humans [1].

Although the soil through structure and composition fulfills the functions of a biological station with all stages of treatment - mechanical retention, biological oxidation, ion exchange, chemical precipitation, absorption and assimilation by plants and microorganisms, etc. - its ability to perform these functions started to be overloaded or exceeded more and more frequently, resulting in pollution. Such a pollutant can be represented by the deposition of household residues. The water infiltrated by these deposits and then by their sole and flanks, is an important source of pollution of groundwater, with the most serious effects.

The prospect of a considerable increase in the volume of household waste in the coming years, as a consequence of the development of the consumer society in our country, leads to the increase of the
requirements that are required for the construction of the deposits that house these residues, both quantitatively and especially qualitatively. [2]

The environmental problems created by these potential polluting materials are so complex that activities aimed at protecting the environment, in order to be successful, must accept and implement the concept of "sustainable development".

By virtue of this concept [3], for the protection of the groundwater in the area of household waste deposits, it is proposed to adopt a "clean technology" for the implementation of complex deposition improvements, which will prevent the appearance of pollutants, initially in the most important urban areas, and for the future generalization of these improvements in other localities.

2. The technology of complex arrangement of deposition of household residues

In a realistic analysis, all the technical constructions are characterized by limited duration and operating capacity. In this context, the concept of operational safety becomes decisive. Thus, in the case of depositions of household residues, in addition to a reduction of the danger by selecting and penetrating the residues, it is necessary to use a technology that can guarantee a control of the deposit after the completion of the deposits and in case of partial fall of the safety elements, there is the possibility of repair for to exclude harmful emissions of pollutants for a long time.

The proposed implementation technology, even if it involves important investment works, is justified by the way it solves a very topical issue, regarding the protection of the environment [4]. The essential elements of this complex arrangement of household waste depots refer to:

- the sealing system of the base layer which integrates a safety gallery from which checks and repairs are made;
- deep sealing walls that do not allow the circulation of the groundwater located below the deposit site so that in case of infiltration of some polluting substances in this area, their area of influence is limited;
- the sealing system that limits the flow of water infiltrating through the deposits and avoids air pollution with substances resulting from the anaerobic decomposition of household waste which can have serious implications on the hygiene-sanitary balance of the population living in the area, due to the favoring factors, potentially involved in the emergence and proliferation of vectors or viruses of human diseases.

A complex layout system generally contains:

1- The surface of the deposition site; 2 - Basic layer for sealing, of clay; 3 - Protective film of the base layer; 4 - Infiltration water collector; 5 - Filter; 6 – Protective layer from the ground; 7 - Prism of support; 8 - Groundwater layer; 9 - Guide beams; 10 Deep sealing walls; 11 - Waterproof layer; 12 - The drainage of infiltration water; 13 - Discharge collector; 14 - Marginal grid of the deposit; 15 - Discharge collector; 16 -Discharge fireplace; 17 - Discharge collector; 18 - Fireplace for measuring infiltration water level and groundwater level; 19 - Discharge collector; 20 - Access road; 21 - Unloading well; 22 - Vegetable layer for recultivation; 23 - Upper sealing layer, of clay; 24 - Geotextiles; 25 - Fine sand layer; 26 - Coarse sand layer; 27 - Equalization layer, from the ground; 28 - Household waste.

2.1. Basic layer sealing technology

The sealing of the base layer of household waste deposits must be designed to withstand very high demands. As such, the solution considers the conditions for the formation of the deposits, the mode of their subsequent exploitation and the degree of safety required for such a construction, which aims to prevent the occurrence of polluting emissions for a long time.
The basic layer sealing system has the following main parts in its structure:

1 - Basic layer for sealing, of clay; 2 - Protective film of the base layer; 3 - Infiltration water collection net; 4 - Filter; 5 - Collector; 6 - Filter protection geotextile; 7 - Equalization layer; 8 - Protective layer of earthy materials; 9 - Deposits of household waste.

For the realization of this sealing system, it is recommended to use the following technology: The surface of the site of the future deposit, is uncovered on a depth of 15 cm and the removed vegetal layer is transformed into temporary deposits so that it can be used in the creation of the upper layer of deposits, for recultivation.

The uncovered surface of the site is scarified to a depth of 30 cm in order to destroy any existing sewers or cracks, after which the layer is compacted. By these works, a uniform compacting of the surface is ensured, in order to avoid that later when it will be placed under load, it will be tested unevenly and thus the compromise of the base layer for sealing will occur. There is also an improvement in the carrying capacity of the deposit foundation.

The natural sealing work consists of depositing 6 layers of mineral materials with high clay content, with the maximum thickness of each layer of 25 cm. The layers are leveled and moistened and compacted until a permeability coefficient \( k = 5 \times 10^{-10} \text{ m / s} \) is obtained. On the surface of the last sealing layer leveled at a slope of 1\%, the protective film for the artificial sealing having a minimum thickness of 3 mm, and the tensile strength of 30 kg / cm bandwidth, shall be tightened.

2.2. Infiltration water capture technology

The realization of the integrated drainage system for capturing the infiltration water that has passed through the deposition of household residues involving possible polluting materials consists of the following works:

Above the combined sealing system, it realizes a system of streams of granular material of \( \phi 16-32 \) mm, casts the distance of about 20 m, to capture the infiltration water and to conduct it by gravitational flow spreading collector. For this purpose, the streams will have a minimum slope of 1\%.

Transversely in the direction of the streams is located the collector that takes the flows collected by them and discharges them in the safety gallery. The collector is covered with a filter made of \( \phi 16-32 \) mm granular material. To improve the stability of the prism of the filter material, it is covered with a geotextile filter material. When designing this drainage work, it will be common for the prism from the filter material to be able to take over the function of the collector if it collapses.

On the route of the collectors will be made to download and control homes located outside the depots.

In order to protect the drainage system and even the basic sealing system against deterioration by the deposition of corner residues, as well as against the thermal demands resulting from the burning of some components thereof, a layer of earth with a thickness of 1, 5m will be deposited.

2.3. Safety gallery execution technology

In order to ensure the supervision and control of the behavior of the deposition of household residues in operation, in the system of sealing and drainage is integrated into a gallery of circulable safety, conceived in the plan in the form of Y.

The safety gallery consists in principle of the following component parts:
1- The infiltration water collection net; 2- Equalizing layer, of granular material; 3- Protective film of the base layer; 4 - Infiltration water collector; 5 - Base layer for sealing, of clay; 6 - Prism of the earth for gallery protection; 7 - Safety gallery, 8- Compacted soil layer; 9 - Equalization concrete layer; 10 - Groundwater level control pipeline; 11 - Groundwater; 12 - Guide beams; 13 - Sealing wall; 14 - Waterproof layer in which the sealing wall is embedded.

The safety gallery execution technology involves the following main tasks: The tranche is executed in which the gallery is to be built. The land resulting from the digging of the trench is moved to temporary deposits. The trench is divided into sections and sealed with palpable walls. Exhaustion is then performed until the groundwater level drops below the bottom of the trench. After bringing the sealed enclosure to the dry the technological process continues.

On the bottom of the trench will be deposited successively 6 layers of 30 cm each, from the excavated soil, they will be moistened and then compacted to D = 100%. This results in a support layer with improved load-bearing capacity that will not be charged unevenly under the influence of the tasks created by the gallery and the deposits, ensuring the integrity of the gallery during operation. A layer of leveling concrete is deposited on the gallery site.

After the construction of the gallery in its lateral parts, waterproofing is performed. Then layers are deposited from the soil in the temporary warehouses and compacted only by mechanical means with static action so as not to influence the reinforced concrete construction of the gallery. The compacted earth prism placed around the safety gallery ensures its protection and stability in operation. Along with the construction of the prism, the connection pipes between the gallery and the infiltration water collection manifolds and the groundwater level control pipes will be realized.

The pumped water and the infiltrated water collected above the basic sealing system will be treated in a highly efficient technical system. The technological scheme of this system provides a biological step, a chemical oxidation step and an additional filter and active carbon absorption. Water purified in this way, devoid of polluting substances is conducted in the public sewerage or directly in an emissary. The construction of the basic sealing system as well as the integrated drainage system will be carried out over the entire safety gallery assembly.

It is mentioned that by means of a system of pipes located below the level of the groundwater, its level can be fixed in the control space under the basic seal so as to avoid drying the clay layer. By periodically analyzing samples of groundwater or infiltration, changes in their quality in different areas of the deposit can be discovered early and the interventions required to prevent polluting emissions for a long period can be discovered.

2.4. Deposition surface coating technology

Covering household waste deposits with a sealed surface layer is justified by the fact that thus reducing the water flows from precipitates that can be infiltrated through the deposit and at the same time avoiding air pollution by gases charged with substances from chemical transformation processes residues of organic nature and which would be emitted by deposits in the atmosphere.

As a surface seal, a new combination consisting of high clay mineral content and a capillary barrier underneath is provided.

The surface layer sealing system comprises:

1 - Precipitation; 2 - Surface vegetable layer; 3 - Recultivation layer; 4 - Sealing layer, of clay; 5 - Geotextiles; 6 - Fine sand layer; 7 - Coarse sand layer; 8 - Equalization layer; 9 - Deposits of household waste. [5]
The logical order of the coating and sealing work at the top of the warehouse is as follows: The top surface of the deposition of residues is covered with a layer of 20 cm, of the earth to obtain a leveling and leveling. Then a layer of coarse sand with a thickness of 30 cm is deposited, over which a layer of fine sand is placed in a thickness of 40 cm. These two layers form a capillary breaking zone which will have the effect of capturing and transporting a large part of the water from the precipitates, avoiding their infiltration through the mass of the residues.

To establish the layer of fine sand, a geotextile material is deposited on its surface. Then the sealing layer is made of a thickness of 60 cm, from a soil with high clay content. The clay soil is deposited in 30 cm layers, moistened and compacted until a permeability coefficient $k = 1 \times 10^{-8} \text{m/s}$ is obtained.

The entire warehouse is then covered by a vegetative and recultivating layer, with a total thickness of 2 m, to prevent the sealing of the roots from the vegetation that is cultivated or planted on the surface of this layer.

The elimination of the biogas that is formed in the sealed warehouse is done by means of vertical wells. The gases aspirated even during the formation of the deposit, can be burned with the help of a non-polluting installation, analyzing according to the flow obtained their thermal recovery.

2.5. The technology of execution of the walls molded for sealing
The molded walls provided as an underground sealing system, separate the existing space under the location of the surrounding groundwater deposits. Thus, an enclosure is created which excludes the possibility of the emission of a pollutant, on the groundwater path.

Molding walls are continuous concrete walls, with depths up to 30 m, depending on the share of the waterproof layer below the deposit. Their accomplishment is done by filling a trench dug beneath benthic mud, with an impermeable material, following a special technology used in our country with good results.

3. Conclusions
Groundwater pollution can occur from the emission of a pollutant through the soil, which then interacts at biotic and abiotic levels by entering the food chain and reaching directly or indirectly in humans.

Such a pollutant may represent the deposition of household residues. The prospect of a considerable increase in the volume of household waste in the coming years, as a consequence of the development of the consumer society in our country, leads to the increase of the requirements that are required for the construction of the warehouses that house these residues, both from a quantitative point of view and especially from a qualitative point of view.

By the virtue of the concept of sustainable development, the present paper proposes the accomplishment of a complex arrangement for these deposits, having as an effect the protection of the groundwater.

References
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