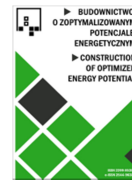




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The application of anti-filtering polymer mass to solve the water storage problem in highland regions

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Abstract: Using additives with water absorbing characteristics enables us to increase the amount of water in natural basins and significantly decrease the amount of water for agricultural usage. Despite various additives already existing, they are yet to be commonly used due to high cost price, complex technology, toxic impact and instability in biological and atmospheric conditions. However, the «Natlen» composite, which is a naturally based additive, is ecologically safe. It has a long shelf life, is cheap and provides high antifiltering rates. The composite is eruptive with dispersity of any type and is jelly when boosted. In an anti-filtering layer it never cracks under static and dynamic influences. It has no seam and is resistant to aggressive liquids. It is ecologically safe. «Natlen» composite is recommended for building water basins in pastures, where it can particularly be used to satisfy the demand for drinking water for cattle.

Keywords: waterproofing, basin, resistance, economic effect, construction, highlands, reservoirs, precipitation

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Introduction

Taking into account that the level of rivers in Armenia is low during the crop-growth season and can not satisfy the water demand of all crops in the region, especially because of widespread surface watering, there is a high water leakage.

This situation is compounded by the absence of a suitable method for calculating the parameters of irrigation regimes for crops in local conditions. At the same time, in mountainous countries, such as Armenia, there are many sand and clay basins through which the water is filtered, causing the need to increase the irrigation frequency and the amount of water supplied (Tokmajyan et al., 2018).

Water course losses affect the efficiency of exploitation of basins. There are many examples of the efficiency of exploitation of hydraulic works being lower due to filtration losses. For instance, the usable storage of the Aparan reservoir is 90 mln/m³ from which 36 mln/m³ is lost to filtration (Yeroyan, 2007). Being unique, highly effective, ecologically clean and having no comparable substitute, “Natlen”, which is used for waterproofing important facilities and structures (subway tunnels, storage dams, dams, canals, reservoirs, treatment facilities, etc.), has the ability to increase ten times in size when released into an aquatic environment (Galstyan et al., 2020).

The authors of this work carried out a series of experiments under laboratory conditions to determine the ability of “Natlen”, a polymer-mineral material, to retain moisture in the soil. The studied material was mixed with substrate and laid in various ways. Then the container with the substrate and the polymer-mineral material was saturated with moisture and for a certain time the moisture remaining in the substrate was measured in order to determine the optimal packing options and the optimal amount of material to use. The following combinations of the substrate with “Natlen” are of particular significance:

1. Pure substrate without polymer-mineral material “Natlen” to control the measurements of various variants of mixtures.
2. A certain amount of polymer-mineral material “Natlen” evenly mixed with the substrate in different proportions.
3. At the bottom of the container, a small layer of “Natlen” polymer-mineral material (PMM) (up to 1 cm as a layer of material of 2 cm or more turns into a good insulator and practically does not allow water to pass through) reduces filtration, evaporation and allows water to be stored in a container.
4. Two-layer placing: a layer of substrate mixed with PMM is placed on the bottom of the container and on the top clean substrate without “Natlen” PMM is added.
5. Three-layer placing: bottom and top layer of the substrate mixed with PMM is put in the container with a layer of clean substrate between them providing a decrease in filtration and evaporation (the liquid being absorbed in the polymer-mineral material “Natlen” in the substrate does not evaporate well).
6. Holes of small diameter and depth inside the substrate which is put in the bottom of the container are filled with polymer-mineral material “Natlen”. The number of holes and their size is determined by the amount of material that must be added to the substrate for a set of additional poorly evaporating water.

Mixing “Natlen” polymer-mineral material with the substrate and putting it on the bottom of the container and in the holes inside the substrate saves more water,

thereby increasing the moisture capacity and also reducing evaporation from the surface of the substrate and filtering through the bottom of the container.

The results of testing the polymer-mineral material “Natlen” are shown in Table 1.

Table 1. The results of testing the polymer-mineral material “Natlen” (*own research*)

No	Indicators Unit of measurement	Normative meaning	
1	Appearance	Grey powder	Grey powder
2	Filled density [kg/m ³]	1400-1600	1560
3	Coefficient of filtration [m/day]	5x10 ⁻⁵	2.3x10 ⁻⁵

Currently, moisture-swelling polymer obtained from oil industry waste is often used to retain substrate water. Such material is used in agriculture. Under laboratory conditions, the water retention capacity of soils without additives and with dry additives added to the soil was studied. Under field conditions different methods of using polymer additives and its effect on the growth, development and yield of wheat were studied (Danilova & Kozereva, 2007; Danilova, 2016).

While applying hydrogel in dry form, it is possible to partially solve the problem of high groundwater. It absorbs extra moisture from the roots of plants. However, in our opinion this method is not only ineffective in the fight against high groundwater, but can also lead to the opposite effect. Water will remain in the soil in a form of swollen gel and this will not lower the groundwater in any way. This is because, according to the rule of joint vessels, new water will immediately fill in the space left by the water absorbed by the hydrogel.

By injection, “Natlen” is applied, in order to waterproof channel beds, sides of reservoirs, canals, dams, pools, basins, fountains and settlers with technical, reverse and radioactive water. The thickness of the waterproofing layer made up of dry mixture depends on the components of the courses and comprises from 5 to 10 cm thickness and can stand hydrostatic pressure of up to 100 aqueous columns without filtration. “Natlen” can also be used for waterproofing the foundations, walls, roofs, for the installation of waterproofing and anti-filtering curtains, screens from ground and flood waters in various underground building structures, constructions and buildings of all types. It is possible to use the material for the quick construction of temporary dams or other protective devices that are urgently needed during spring floods or floods in general. The construction and operation of protective dams with a waterproof flashing layer made up of a mixture of pebbles, gravel and crushed stone is no less effective.

The technical characteristics of the material are as follows:

- inactive to the aggressive environment and nonpolar liquids – non reactive,
- frost resistant during the operation of the structure for no fewer than 200 series,
- chemical resistant to the aggressive environment,
- sulfate resistant – acid resistance,

- stability in the range of pH from 4 to 12 units,
- stability of the material in its packing 1:3 (angle of natural overflow of sand),
- stability of the material to the flow of ground waters – resistant to scouring from waterflow with speeds up to 5 m/s, not subjected to suffusion,
- stability of the material’s physical-chemical properties taking into account freezing and melting,
- long lasting usage – more than 100 years,
- resistant to frost damage between the indicators of sand and sandy loam.

Polymer-mineral materials can also be used to accumulate moisture in the soil and to increase productivity in rain fed conditions (<http://gydromix.ru/produkcija/gdm/natlen-1/>; *Hydrogel and plants*//floweryvale.ru/houseplants/hydrogel-and-plants.html; Tokmajyan et al., 2018).

The basis for flashing the underground structures can be compacted soil, the surface of the concrete layer cleaned from stones and construction debris or crushed stone preparation.

1. Conflict setting

This article’s aim was to construct a basin by using the natural concavities of the land and waterproof the basin using “Natlen” in order to satisfy the need of drinking water for cattle.

2. Research results

“Natlen” waterproofing material can be used for collecting water in mountain regions. In particular, it can be used for the construction of small basins (500-1000 m³), for the collection of precipitation waters in highland pastures and to provide drinking water for cattle (Fig. 1).



Fig. 1. A small basin to provide the cattle with drinking water in highlands (*own research*)

The authors suggested building such basins in the form of a cut cone. The angle of inclination of the slopes to the horizon should not exceed 25-27°. In order to protect the “Natlen” waterproofing material during operation, coarse gravel or, more preferably, lustrous river stones should be used. Apply a 5 cm thick lustrous layer of gravel on a 5 cm thick sand pillar and top. Then fill in the waterproofing material and continue topping (Fig. 2). The final site of the basin is given in Figure 3.



Fig. 2. Topping of the basin floor (*own research*)

After finishing the topping, the prepared surface is watered. After drainage, the basin is filled with water for testing. After testing, when we are sure that filtration of floor and slopes is absent, the basin is emptied (by siphon or other method) and the surface of the floor and slopes is covered with large stones so that the anti-filtration layer is not damaged by people or animals during operation.



Fig. 3. The sight of the basin (*own research*)

The angled slopes of 25-27° to the horizon will enable the cattle to get to the floor of the basin as the water level reduces.

Conclusion

When considering the movement of the cattle to highland regions in summer, where a strict deficit of water is noticed, then the construction of such basins and collection of precipitation waters is of the utmost economic importance. Taking into account the fact that one animal needs 100 liters of water every day, then to keep 100 animals will take 1-2 transports of water in water tankers up to the mountains by rough roads. The construction of such basins with 1000 m³ water capacity will save 60-120 such transports taking into account evaporation. The economic effect is obvious.

This material can also be used in agriculture to increase the moisture capacity of soils when growing plants in rain fed conditions and with limited irrigation. The effect of the use of polymer-mineral material is aimed at using the swelling properties of this material which saves enough water inside the soil, to reduce the filtration coefficient, to increase the moisture capacity of the soil and to reduce the erosion of fertilizers.

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