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TECHNOLOGICAL BASING OF USING PHYTOTECHNOLOGIES IN CLEANING SEWAGE OF SMALL COMMUNITIES

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1 INTRODUCTION

Currently 70% of polluted sewage is coming from minor sources, located in the countryside. This is because the overwhelming majority of small settlements don't have any facilities for cleaning sewage, and existing facilities work unsatisfactorily because of the wrong maintenance and absence of funds for repair.

In many countries during the last decades little villages got rid of traditional ways of cleaning sewage because of unreliability and difficulty in exploitation of cleaning facilities of standard type. Instead of those, widely used are facilities, which are based on intensification of natural process of self-cleaning of water, using microorganisms and highest aquatic vegetation. These methods of cleaning sewage using vegetation components are called phytotechnology. The most widely spread facilities using phytotechnology are bio-ponds and bio-plateaus. In this project I examine bio-plateaus in detail.

Bio-plateau is an earth structure (rarely ferroconcrete), which is made in half-hollow half-embankment

Cleaning structures based on phytotechnology are divided into

-structures of mechanical cleaning (precipitation tank)
-seepage blocks with vertical and horizontal movement of water
-shallow blocks
-floating Bioplato
-channel Bioplato
-coast Bioplato

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2 CONSTRUCTION SPECIFICATIONS

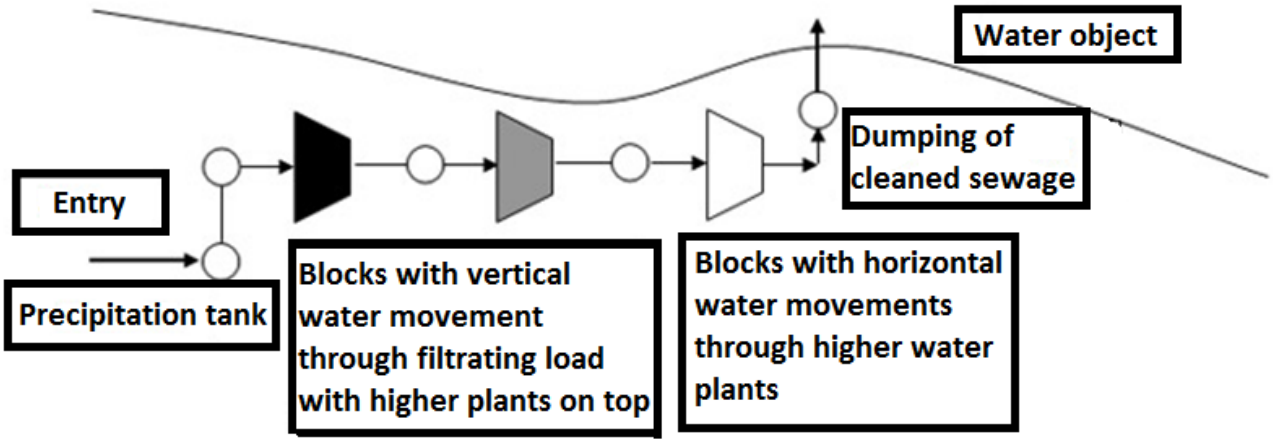

Figure 1. Plan of complex cleaning of sewage using phytotechnology "Bioplato".

Infiltration Bioplato is a ground filtration structure filled with crushed stone, gravel, haydite, sand or other discret filtrating materials.
There are two types of infiltration Bioplato:
-with horizontal filtration
-with vertical filtration
There are trees, bushes or grass planted on the surface of the structures. Cleaning of sewage takes place because of the symbiotic activity of vascular plants, biofilm, microphytes, microorganism, mushrooms and ray fungus in the rizosphere of the plant system rootage.
In horizontal filtration blocks, water is cleaned when it passes through thick filtration layer under the impact of microorganisms and plants root zone.

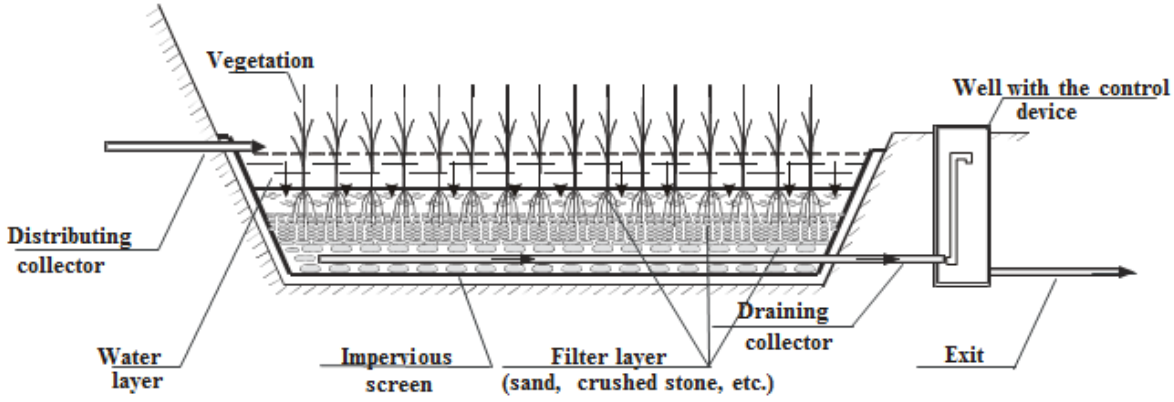

Figure 2. Scheme of filtrating Bioplato with vertical filtration.

In vertical filtration blocks water, as it gets on the block (section), is firstly distributed along its surface in horizontal direction and at the same time because of gravitational force moves down, passes through the root system and filters and exits through scruppers into the well. Water is cleaned in the following stages:
-in open water zone
- in the plants root zone
- in the filter zone

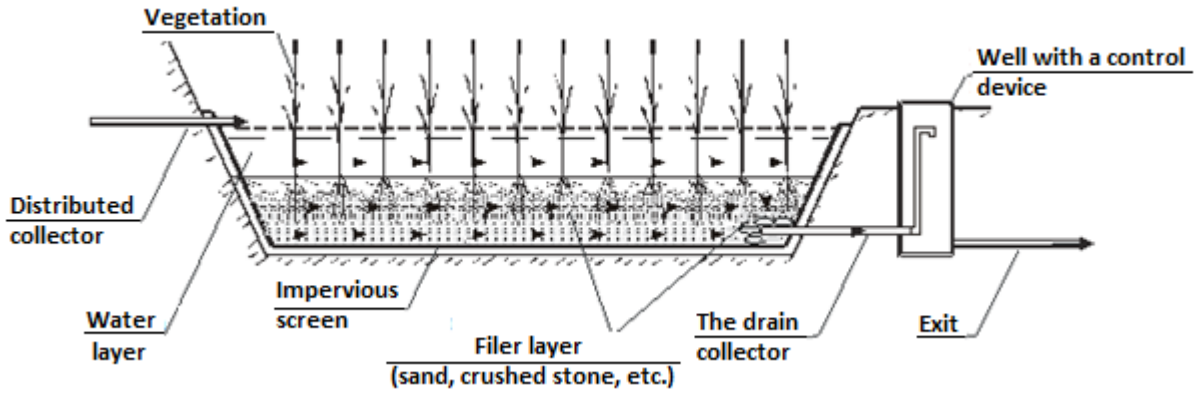

Figure 3. Scheme of filtrating Bioplato with horizontal filtration.

Filtrating Bioplatos, which don't have any open surface are called subsurface filtrating Bioplatos and are used if a distance to the residential sector is less than the size of the sanitary zone.
In these structures the filtrating layer is covered on top by ground plant layer, which consists of water plants. So the peculiar domestic sewage smell doesn't exist. Cleaning happens only in rizosphere of plants root system and filtrating layer because of activity of group of vascular plants and biofilm, microphytes, microorganism, mushrooms and ray fungus.

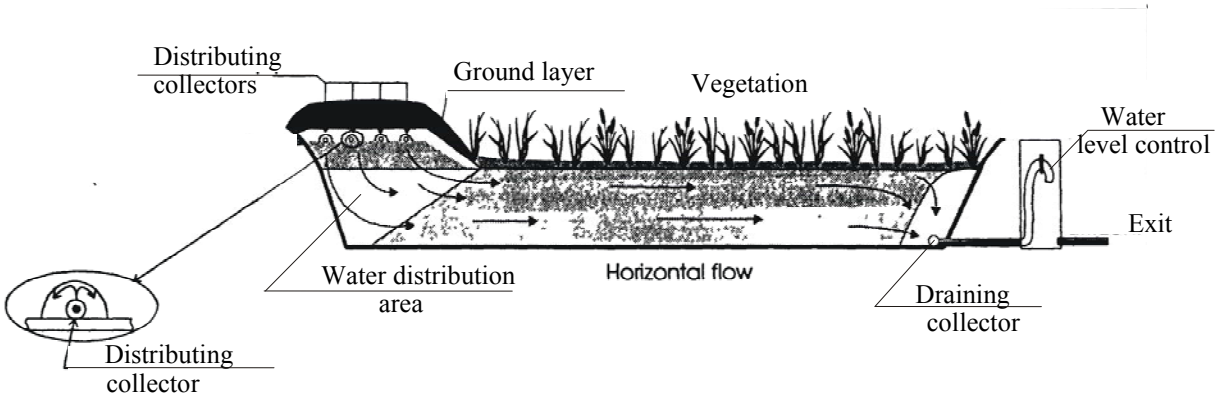

Figure 4. Scheme of subsurface filtrating BIOPLATO.

Surface Bioplato. After cleaning through the infiltration blocks, sewage is further cleaned at the surface block of Bioplato with horizontal water movement through the root zone and the overground part of artificially made group of higher water plants. Bottom and sides of artificially made blocks are isolated by protective anti-filtering shield of the same type as in the infiltration Bioplato.

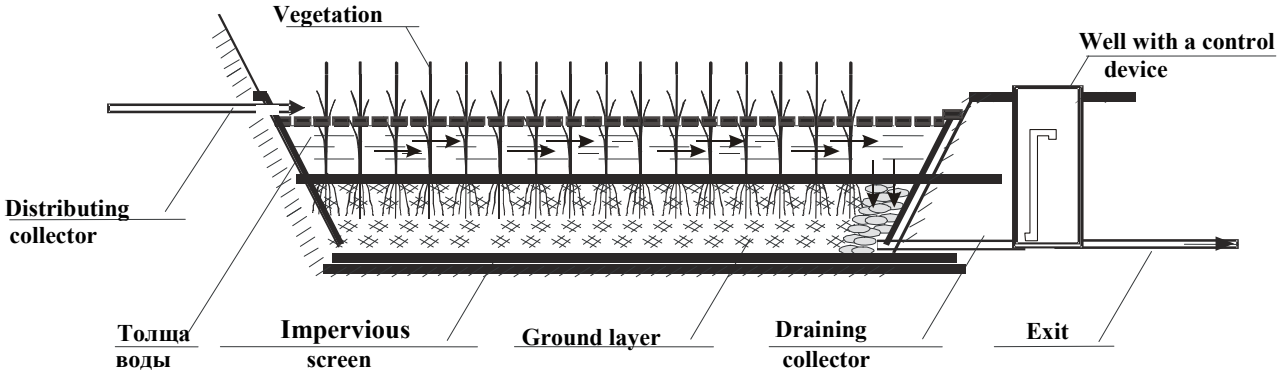

Figure 5. Scheme of surface Bioplato.

Bioplato with floating constructions is a system of tanks filled with water, at the surface there are nets of synthetic fibers, stems and leaves of water plants. There are plants with developed root systems planted into cells.

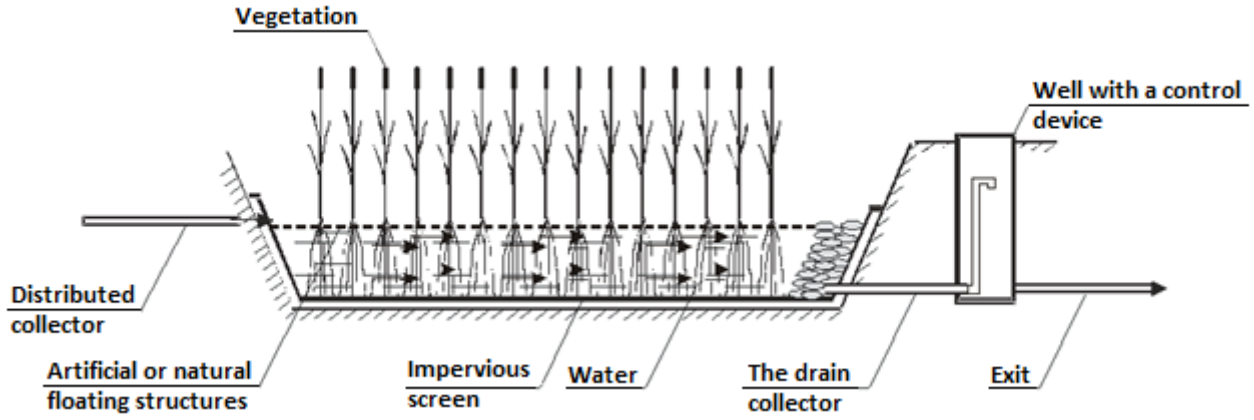

Figure 6. Scheme of bioplato with floating constructions

Bioplato with freely-floating plants is a system of water-filled tanks and plants (water hyacinth) or seaweed floating on the surface.

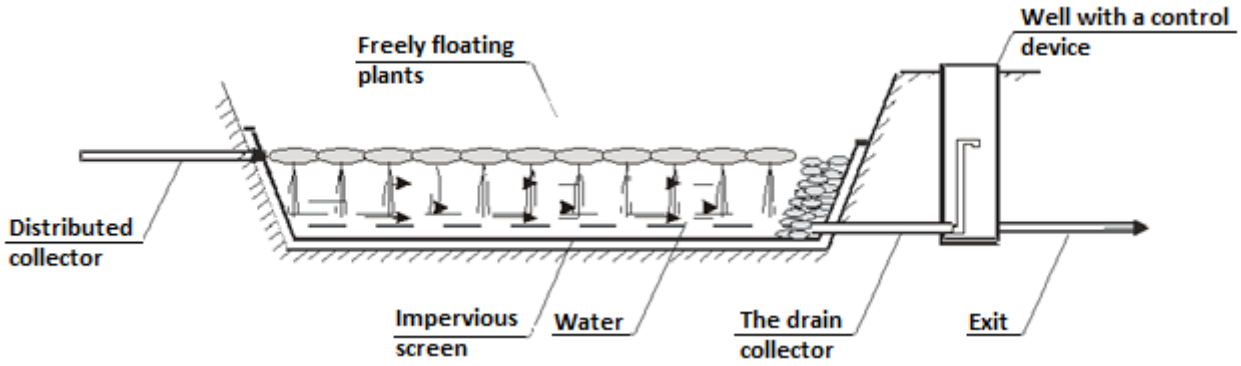

Figure 7 Scheme of bioplato with freely-floating plants

Constructions of these types proved themselves well in cleaning water from floating admixtures (foam, flakes, mineral oils)

3 TREATMENT CHARACTERISTICS

Main indicators of treatment are given below:

- By BOD 90-95% (under 5-6 mg/l)
- By COD 85-95%
- By suspended matters 95-99% (under 4-5 mg/l)
- By mineral oils under 0-0.05 mg/l
- SSAS (surface active substances) over 85%
- By mineralization 20-99%
- Cleaned water transparency reaches 30 cm by Snellen
- By bacteriological index 98-99%
- Smell is completely eliminated
- Amount of dissolved oxygen is increased
- Amount of nitrogen and phosphorus compounds is decreased by 35-60%

The following graphs show the measurements of main pollutants taken on a number of Bioplato-like structures during the cold and warm seasons.

Table 1. Measurements of main pollutants taken on a number of Bioplato-like structures during the cold and warm seasons

Indicators	**Sampling points**					**The overall efficiency of the bioplato, %**
	1 (enter)	**2 (enter to 1-st block)**	**3 (exit from 1-st block)**	**4 (exit from 2-nd block)**	**5 (exit from 3-rd block)**	
Transparency, cm						
The average -summer	0,43		5,94	15,42	27,07	
Average - Winter	4,06		6,97	18,53	26,91	
The average for the period of observation	2,25		6,46	16,97	26,99	
The smell, the score						
The average -summer	4,00		3,50	2,00	0,30	
Average - Winter	3,00		3,10	1,20	0,20	
The average for the period of observation	3,50		3,30	1,60	0,25	
Suspended solids, mg/dm^3						

The average for the period of observation	284,99	212,75	80,72	25,02	13,58	95,23%
Dissolved oxygen, mg/dm^3						
The average -summer	1,77		0,59	1,16	4,77	
Average - Winter	2,82		0,08	0,95	8,89	
The average for the period of observation	2,29		0,33	1,06	6,83	
COD mgO_2/dm^3						
The average -summer	241,84		48,01	34,61	27,58	88,60%
Average - Winter	135,29		79,99	21,83	19,96	85,25%
The average for the period of observation	188,57		64,00	28,22	23,77	87,40%
BOD mgO_2/dm^3						
The average -summer	116,84		24,49	11,95	5,11	95,62%
Average - Winter	38,52		26,88	5,72	2,47	93,59%
The average for the period of observation	77,68		25,69	8,83	3,79	95,12%

Permanganate oxidation mgO_2/dm^3						
The average -summer	36,04		12,93	7,88	7,60	78,91%
Average - Winter	25,32		21,05	5,49	4,74	81,29%
The average for the period of observation	30,68		16,99	6,68	6,17	79,89%
Ammonia nitrogen, mg/dm^3						
The average -summer	59,29		52,84	43,06	30,27	48,95%
Average - Winter	50,43		87,09	37,16	23,51	53,37%
The average for the period of observation	54,86		69,97	40,11	26,89	50,99%
Orthophosphate, mg/dm^3						
The average -summer	0,84		0,40	0,33	0,37	55,56%
Average - Winter	0,26		0,22	0,15	0,12	54,19%
The average for the period of observation	0,55		0,31	0,24	0,25	55,24%
Total phosphorus, mg/dm^3						

The average -summer	5,96		7,058	7,10	5,32	10,73%
Average - Winter	6,70		6,07	7,95	5,10	23,88%
The average for the period of observation	6,33		6,56	7,53	5,21	17,69%
SSAS, mg/dm^3						
The average -summer	0,281		0,125	0,056	0,018	93,46%
Average - Winter	0,393		0,272	0,114	0,068	82,70%
The average for the period of observation	0,337		0,198	0,085	0,043	87,19%
Chlorides, mg/dm^3						
The average for the period of observation	44,21		49,72	51,33	42,43	4,04%
Sulfates, mg/dm^3						
The average for the period of observation	262,57		329,95	239,04	244,84	6,75%
The dry residue, mg/dm^3						
The average for the period of observation	870,33		1175,4	969,38	974,08	-11,92%

Bacterial contamination, (coli - forms, the index x10^5)						
The average -summer	11257		309,24	102,06	22,62	99,80%
Average - Winter	4775,6		1206,3	503,41	4,03	99,92%
The average for the period of observation	8016,4		757,79	302,73	13,32	99,83%
Bacterial contamination, (coli-phages (PFU x1000))						
The average -summer	2615,7		36,47	9,25	6,40	99,76%
Average - Winter	526,43		109,86	9,14	3,86	99,27%
The average for the period of observation	1571,1		73,16	9,20	5,13	99,67%

- Cleaning of suspended materials is of higher quality during winter period because of decrease in water speed and increase in process of sedimentation
- Amount of dissolved oxygen increases in winter period because most of the water surface is covered by ice
- Amount of BOD and COD depends solely on the number of organic pollutants in different periods
- Improvement in water purification from bacteria depends on the water temperature. If the water temperature is too low, the bacteria and viruses die

Figure 8. Working constructions.

As you can see on the slide blocks of Bioplato structure have a big advantage in aesthetic and can be used as leisure zones or decorating reservoirs. The major part of costs for building this type of structures is the cost of area, used for building.

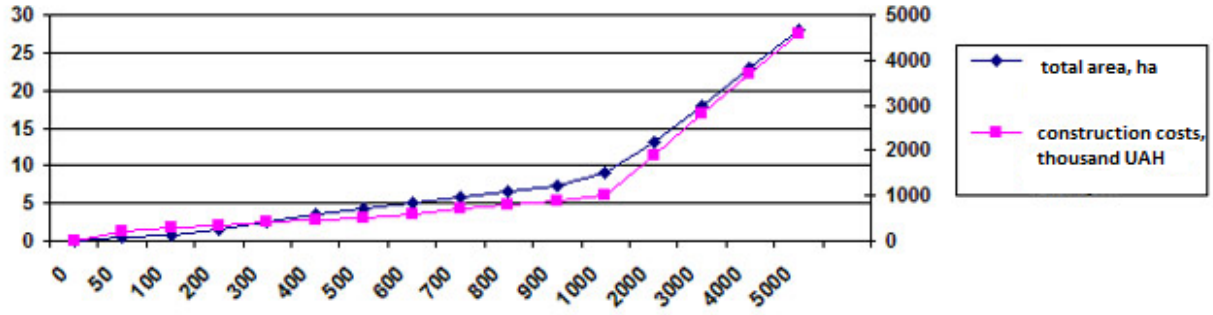

Figure 9. Graph of cost of bioplato compared to its building area.

Compared with the traditional sewage-cleaning structures, the Bioplato has some major advantages. Since nearly all works are connected with soil and large-scale reinforced concrete and iron elements are not used, electricity is not needed, the main long-term components are polyethylene pipes and screens and local materials, the capital expenses are far lower.

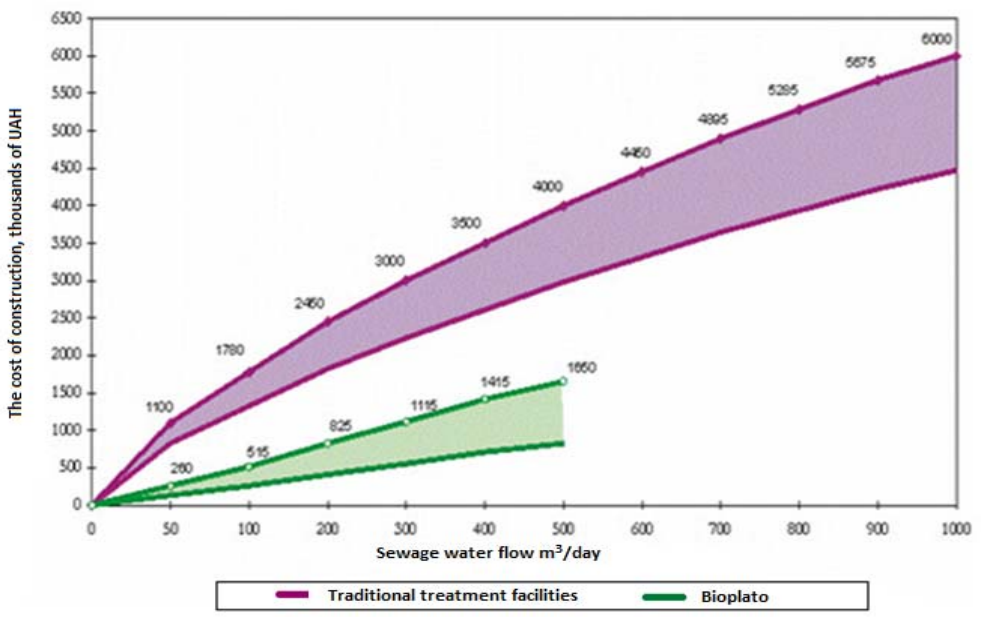

Figure 10. Comparison of capital investment into the cleaning structures.

Absence of reagents, electricity, jobbing once in 5 years, major repairs once in 40-50 years, self-regulating system.
As for the daily maintenance, it is lower due to the fact that we do not need electricity, chemical agents and regular technical maintenance and big salaries for a number of employees. The repair periods are 5-10 years and consist of only mixing og the top layer of filtering materils and re-planting.

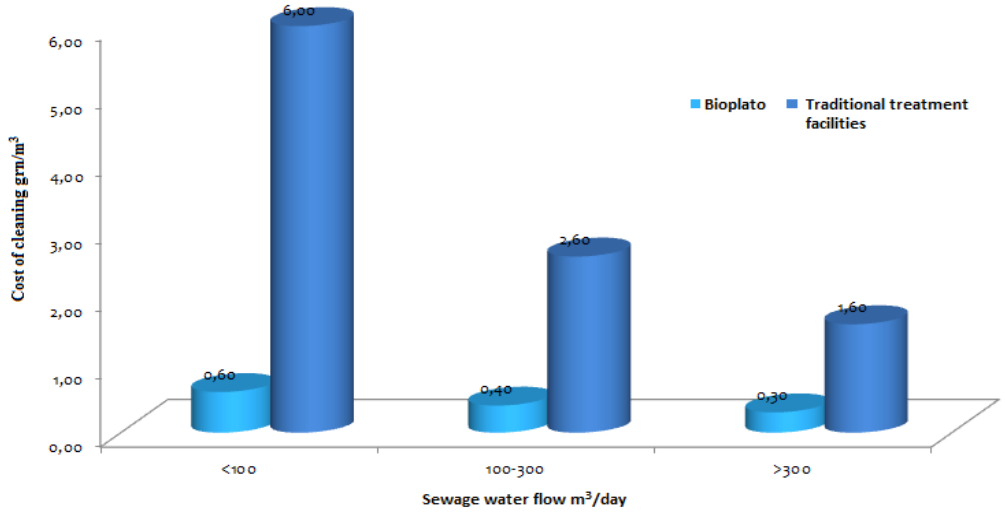

Figure 8. Cost per unit for exploiting of cleaning structures

4 CONCLUSION

The table (Appendix A) shows total expenses, which are clearly indicate the Bioplato's advantages due to the above-mentioned reasons and also big role play the long periods between maintenance, which are 30-50 years for the CIS countries and 50-75 years for Western Europe and the USA.

- The report proves that construction based on phytotechnology of BIOPLATO type is an optimal choice for cleaning sewage in cottage settlements, small towns and camps.
- The analysis of literature sources gives economic and technological basis of using BIOPLATO complex along with traditional cleaning structures or as stand-alone structures.
- It is absolutely obvious that BIOPLATO, compared to classical cleaning structures, has an esthetic advantage. It can be built with local materials and plants, so it will not stand out against the surrounding nature's complex.
- Phytotechnology structures are also notable for proliferation of the natural self-cleaning principle, which makes the structure safer for the environment and saves workers from contacting hazardous chemical agents and other dangerous substances.

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