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Efficiency of geotextile filters in dewatering wastes (sludge) from water treatment works

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ABSTRACT: This paper evaluates the efficiency of geotextile filters for sludge from a compact water treatment plant (WTP). The key aspects required in the methodology of selection and designing geotextile filters for sludge from dewatering was investigated based on laboratory tests results. The analyses were supported by the measured filtrated volume of water and turbidity resulting from variable head permeability tests carried out in two geotextiles and using the conventional granular filter (sand and gravel). The results of the present study showed that more than 75% of the dewatering sludge can be filtrated with low turbidity, which permits that this water can return to the treatment plan in order to be reuse in another cycle. The reduced volume of sludge retained by the geotextile that is transferred to the drying pound increases its efficiency by reducing the drying time. The low volume of the dry waste can be removed and the geotextile can be easily cleaned or replaced when needed. These procedures significantly reduce the volume of water needed in dewatering and also avoids waste discharges in the environment.

1 INTRODUCTION

Geotextiles have been intensively used for filtering purposes all over the world. Their characteristics of easy installation, control and maintenance represent a versatile solution in hydraulic applications and environmental protection against waste discharges. In the last years, geotextile filters have also been used for filtering of dewatering of material with high humidity, such as sludge from domestic sewage treatment, industrial and mining waste and sludge from water treatment plans. Even though experience shows that geotextiles for dewatering are technically and economically accepted, this new applicability of geotextiles requires specific criteria to evaluate their behavior during installation and operation, and also requires the understanding of the interaction mechanism existing between water, solid and geotextile.

Compact Water Treatment Plants (WTP) for small communities became an economic and social solution for the public administration in remote areas. The final destination of the sludge resulting from the dewatering of Water Treatment Plants is the major concern nowadays, in other to protect the environment. The discharge of the dewatering in rivers and natural dainage systems is no longer accepted, resulting in the need for studies regarding the final destination for the sludge waste.

Basically, the WTP removes the soil in suspension by chemical treatment using flocolating agent, followed by decantation and filtration. This procedure, depending on the origin of the crude water, can produce a large amount of waste (sludge). The main problem of the WTP is the final destination of the waste generated in the decanting tank and the water needs for cleaning this tank from time to time, which is nedded to guarantee the operation of the filtering process. Many of the WTP installed in Brazil simply discharge the waste into the nearest river or dainage system, causing serious damage to the environment. Those WTP must, in a short time, correct this deficiency in order to attend the requirements of recent environmental protection laws for natural drainage systems. On the other hand, a new solution is required in order to reduce the amount of water waste in the cleaning process – that could be around 5% of the total amount of water treated (AWWA1987).

One of the possible solutions regarding environmental protection is to create a filter system in the drying pound in such a way that the filtered water can return and be reused in the WTP. By doing so, the sludge waste will no longer be discharged in any river or drainage system and the amount of waterloss will be minimum. However, in the first attempts using granular filters, the time efficiency was low and many difficulties for cleaning and replacing the sand arose. New attempts using geotextiles has proven to be very efficient, with easy maintenance.

The new concept to be adopted in the WTP is to use geotextile filters in the dewatering unit in order to separate the sludge from the filtrated water that will return to the system. The small amount of sludge retained by the filter can easily dry at the drying pound and become raw material for the construction of, for example, bricks and ornament vases. In this process, the waste material should also be treated to minimize the microorganisms that might exist at the sludge.

This technique of dewatering using geotextiles started being used in the early 1980s, to retain granular materials during constructions of hydraulic fills and as a protection against erosion (Bogossion et al 1982, Pilarczyk 2000). This tecnique was also applied on waste problems, specially due to economic reasons (Folwler et al 2002, Moo-Young et al 2002).

In this paper, the efficiency of the geotextile filter at the dewatering unit is analyzed in order to investigate, on one side, the amount of water that can be recovered from the sludge waste and, on the other side, the remaining volume of waste that is sent into the drying pound in a compact water treatment plant – WTP. The studies compare the turbidity of the sludge before and after the passage through the geotextile filter and the volume of water that can be recovered from this process.

2 THE WATER TREATMENT PLANT (WTP)

The studies for the dewatering system carried out to prepare this paper are related to a compact water treatment plant – WTP that has been installed in a small community at Guaratinguetá, State of São Paulo, Brazil. This WTP has the capacity to process 50 m^3/h and is mainly divided into chemical dosage unit, pressurize decanting unit, pressurize filter, dewatering sludge unit and the elevated reservoir for the water from the washer unit, as illustrated in Figure 1.

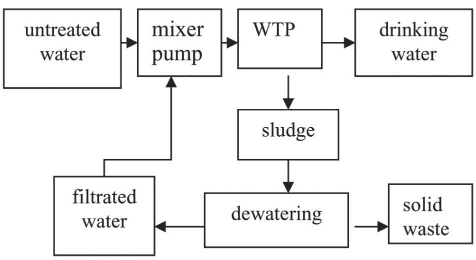

Figure 1. The layout of the WTP with the proposed modification for dewatering and water reuse.

Initially, the untreated water is pumped from a small dam into the decanting unit, passing through a mixing pump. At this stage, the water receives the chemicals agents for clarification and the floculate agents, before entering the decanting tank. The cleaned water is removed from the top of the pressurized decanting tank and goes to a sand filter for retention of any soil particle in suspension and remaining iron component from the process. The sludge is transferred to the dewatering system by lateral pipes.

After the sand filter, the clarified water is pumped into another reservoir with enough pressure-head for distribution to the community. This sand filter also requires periodic cleaning and the waste also goes to the dewatering system. Figure 2 illustrates the WTP.

Figura 2. The compact water treatment plant.

Table 1. Geotextile characteristics.

Type	G-A	G-B
Diameter of the filament (mm)	0,0022	0,0022
Porosity (%)	91,2	91,2
Thickness (mm)	2,05	1,15
Mass per unit of area (g/m^2)	221	138
[1]Number of constrictions	4,64	4,35
[2]Opening size (mm)	0,082	0,082

[1] Urashima & Vidal, 2000.
[2] ISO 12956, 1999.

3 PROPOSED DEWATERING UNIT

The proposed dewatering system for the sludge waste of the WTP is presented in Figure 3. The tank dimensions vary according to the WTP's capacity. But instead of using sand over the gravel, geotextile was used, proving to be more efficient and with easy maintenance.

3.1 *Permeameter layout*

Figure 4 presents the layout of the permeameter built in the research. The permeameters were made of PVC water pipe with 15 cm of internal diameter and 50 cm of length. The permeameter tests for the sand filter consist of one column of 12 cm gravel (3,0 cm diameter) and 8 cm washed sand (0,59 mm diameter)

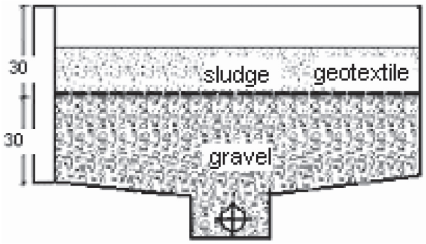

Figure 3. Cross section of the dewatering system (adopted from Mendonça, 2003).

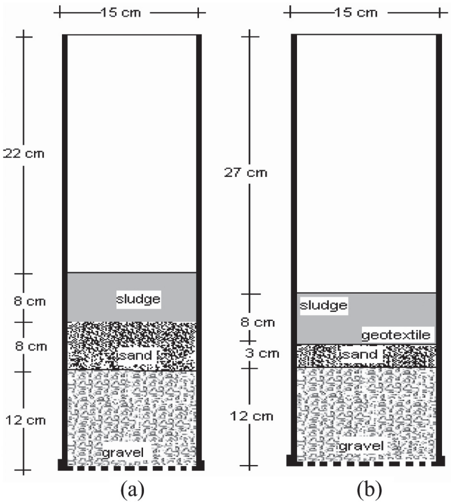

Figure 4. Arrangement of the tests (a) Granular filter and (b) Geotextile filter.

placed on the top. For the geotextile permeability tests, the sand thickness was 3,0 cm to represents the conventional base of the dewaterring unit.

The variable head permeability test programs were carried out by pouring 1,5 liters of sludge into the permeameters with a turbidity os 3860 NTU. The volume changes were measured at different time intervals and samples were collected to determine the water tubidity. All the tests were monitored for up to 450 minutes, where the volume changes were practically constant. Further reduction of the retained waste after this stage is possible by drying technique. After the tests the residual volume and water content of the sludge were also measured.

4 RESULTS AND DISCUSSIONS

A summary of the test results is presented in Table 2. The values represent the average values measured during the test programs for the different arrangements. The volume variations (ΔV) were calculated by the difference between inicial and final measured value, divided by the inicial value. The water content changes (ΔW) were also calculated according the difference between initial and final water content, divided by the initial water content. The final water turbidity represents the average values for all the filtrated water.

Table 2. Experimental results.

Filter	(ΔV) (%)	(ΔW) (%)	Initial turbidity (NTU)	Average final turbidity (NTU)
G-A	75,3	87,5	3860	17,0
G-B	70,0	88,4	3860	224,2
Sand	65,3	88,7	3860	130,0

Typical curves obtained during the tests are presented in Figures 5 and 6. Both curves showed a sharp drop of the water turbidity and retained volume for the first 50 minutes, followed by a practicle stable condition after 200 minutes. For all three conditions tested, the turbidity variation is the same after 200 minutes; however, the sand filter was less efficient regarding filtrated volume. Figure 7 shows the sludge waste that was retained by the geotextile. The photo was taken 10 minutes after the end of the test, indicating a high shrinkage limit of the sludge. According to Table 2, for the geotextile G-A, only 25% of the retained waste has to go to the drying pound and the filtrated water with only 17,0 NTU can return to the water treatment plant. In the other two cases, the turbidity is too high, which would require more chemical agents if returned to the system.

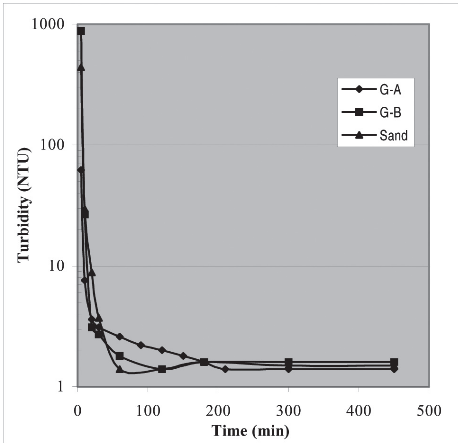

Figure 5. Filtrated water turbidity with time.

5 CONCLUDING REMARKS

Compact Water Treatment Plants are an economic solution for small communities in rural areas. From the present studies the following conclusions can be reached:

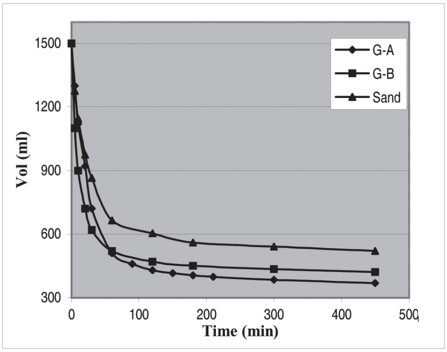

Figure 6. Retained sludge waste with time.

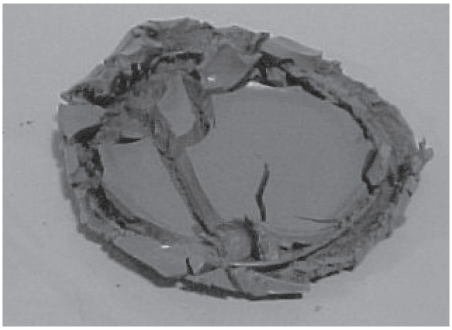

Figure 7. Sludge cake after test.

- The proposed dewatering filter using geotextile has proved to be an efficient method, resulting in very little waste to be discharged into the drying pound. For the geotextile G-A, only 25% of the sludge waste goes to the drying pound.
- The method also proved that a considerable volume of water – 75% of the sludge waste from the dewatering system – can return to the WTP. The process of sand filter cleaning after filtration can also return to the WTP with a considerable reduction of the water losses.
- The proposed dewatering unit system with geotextiles filter requires easy maintenance and the geotextile replacement is simple.
- The environment is protected because no water waste is discharged into the natural drainage system and the resulting dry waste can be used as a raw material for the construction of bricks and ornament vases.

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