Water Treatment Plant Sludge Dewatering

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Using geotextile tubes as dewatering technology may significantly contribute to sustainable treatment of sludge generated in different industries, such as the water industry. This is an economical alternative for dewatering sludge from a Water Treatment Plant (WTP), which prevents sludge from being directly deposited in water bodies and makes it possible to then transfer the sludge to landfills.

Keywords: Geotextile Tube ; Dewatering ; Sludge

1. Introduction

Surface water sources have been increasingly mistreated by releasing debris, which is a result of population growth, industrial activities, and the disorderly occupation of protected areas [1]. Due to the low-quality conditions of water bodies, increasing quantities of chemical products need to be used to treat the water, thus increasing the generation of sludge. A Water Treatment Plant (WTP) sludge is a high-water content material, with a granulometric distribution of fine sediments. It originates mainly in decanters and filter washing, and its characteristics depend on different factors, such as the type and quality of crude water, chemical products used in treatment systems, and the operational conditions of the WTP [1][2][3].

2. Geotextile Tube Technology

As environmental awareness is raised and more stringent regulations related to the treatment of WTP sludge emerge, technologies that aim to dewater sludge to facilitate its treatment and disposal become increasingly more important. Approximately two decades ago, sludge dewatering was carried out almost exclusively with conventional technologies such as settling ponds, mechanical presses, and centrifuges[4]. Despite the various alternatives and technologies available on the market, the main obstacles to WTP sludge dewatering are the high cost and operational complexity [3]. In this context, geotextile tube technology emerged. It was used for the first time in the 1990s by Fowler et al. [5] for dewatering sludge from a sewage treatment plant.

Figure 1. Geotextile tube used to dewater sludge from Water Treatment Plant

Geotextile tubes foster the natural physical separation between the solid and liquid fraction of the sludge, in addition to possibly containing contaminants present in the sludge [6], showing, in some cases, a better performance compared to conventional dewatering technologies. The solid fraction can be transferred directly to sanitary landfills and the liquid

fraction (effluent) can be returned to the interior of the system, or sent directly to water bodies, as long as it complies with environmental regulations, which, if not met, will require a secondary treatment [7].

Chemical conditioning of the sludge and the filter cake formation is a fundamental aspect to be considered in geotextile tubes dewatering. In order to improve the dewatering performance in geotextile tubes, several works have already been developed, using different treatments, test methodologies, residues or sludge, and polymers. Bourgès-Gastaud et al. [8]evaluated the dewatering of residues with different clay content using nonwoven geotextiles, showing the feasibility of using this type of geotextile in dewatering residues with fine granulometric characteristics. They also observed that the samples of residues with less than 25% of silt in the composition obtained less dewatering efficiency than the others, indicating that the sludge composition, and not the geotextile characteristics, determines the system's dewatering efficiency.

Compared with other natural technologies of dewatering, geotextile tubes show a lower dependence on meteorological conditions, as there is a lower input of rainwater through the geotextile [9]. These systems can be manufactured in different sizes, are simple to transport and use, and are significantly more economical [6]. Geotextile tubes in the national and international panorama present great potential for application, making them an efficient and viable solution from a technical and economical point of view.

The filtration criteria of geotextiles have limited applicability in geotextile tubes, due to the fact that the properties of the sludge are the dominant control factors in the filtration process [10][11]. However, knowledge of its filtration, operation, and improvement of design procedures is essential. The success of this application, and the duration of the dewatering and consolidation, depends on the filtration compatibility between the sludge and the geotextiles used to make the tubes [10][12]. Therefore, making preliminary performance tests is fundamental to assess the design conditions before installing the technology. Researchers and professionals have used several test methods alike as a means of evaluating the dewatering performance. These procedures comprise laboratory or field tests [13]. These methods include bench-scale tests (not standardized) such as the cone test (e.g., [9]), Falling Head Test (e.g., [14][15]), Pressure Filtration Test (e.g., [16][17][11][18][19]), and the Pressurized 2-Dimensional Dewatering Test (e.g., [13][20]). Moreover, midscale tests or semi-performance tests such as the Hanging Bag Test (HBT) formalized as a standard by the Geosynthetics Research Institute—GT14 [21] and the Geotextile Tube Dewatering Test (GDT) formalized as a standard by the Geosynthetics Research Institute—GT15 and the American Society for Testing and Materials (ASTM) D7880 [22][23]. Finally, full performance tests have limited use due to their complexity [11][24].

In studies carried out to compare the two methods of semi-performance tests, Koerner and Koerner [25] concluded that the GDT has more advantages compared to the HBT as it is user friendly and it evaluates more parameters such as the filling pressure. Therefore, carrying out this type of semi-performance test together with bench-scale tests is recommended when a full-scale test cannot be done.

References

1. Cordeiro, J.S. Processamento de lodos de Estações de Tratamento de Água (ETAs). In Resíduos Sólidos do Saneamento: Processamento, Reciclagem e Diposição Final; Projeto PROSAB: Rio de Janeiro, Brazil, 2001; pp. 121–142.
2. Reali, M.A.P. Principais características quantitativas e qualitativas do lodo de ETAs. In Noções Gerais de Tratamento e Disposição Final de Lodos de ETA; ABES/PROSAB: Rio de Janeiro, Brazil, 1999; pp. 21–39.
3. Dantas, A.D.B.; Voltan, P.E.N. Métodos e Técnicas de Tratamento de Água, 3rd ed.; LDiBe: São Carlos, Brazil, 2017; p. 1246.
4. Grzelak, M.D.; Maurer, B.W.; Pullen, T.S.; Bhatia, S.K.; RamaRao, B. A Comparison of Test Methods Adopted for Assessing Geotextile Tube Dewatering Performance. Geo-Front. 2011 Adv. Geotech. Eng. 2011, 2141–2151.
5. Fowler, J.; Bagby, R.M.; Trainer, E. Dewatering sewage sludge with geotextile tubes. In Proceedings of the 49th Canadian Geotechnical Conference, St. John's, NL, Canada, 23–25 September 1996; pp. 1–31.
6. Lawson, C. Geotextile containment for hydraulic and environmental engineering. Geosynth. Int. 2008, 15, 384–427.
7. Muthukumaran, A.; Ilamparuthi, K. Laboratory studies on geotextile filters as used in geotextile tube dewatering. Geotext. Geomembr. 2006, 24, 210–219.
8. Bourgès-Gastaud, S.; Stoltz, G.; Sidjui, F.; Touze-Foltz, N. Nonwoven geotextiles to filter clayey sludge: An experimental study. Geotext. Geomembr. 2014, 42, 214–223.

9. Guimarães, M.; Urashima, D.D.C.; Vidal, D.D.M. Dewatering of sludge from a water treatment plant in geotextile closed systems. Geosynth. Int. 2014, 21, 310–320.
10. Moo-Young, H.K.; A Gaffney, D.; Mo, X. Testing procedures to assess the viability of dewatering with geotextile tubes. Geotext. Geomembr. 2002, 20, 289–303.
11. Bhatia, S.K.; Maurer, B.W.; Khachan, M.M.; Grzelak, M.D.; Pullen, T.S. Performance Indices for Unidirectional Flow Co nditions Considering Woven Geotextiles and Sediment Slurries. Found. Eng. Face Uncertain. 2013, 318–332.
12. Shin, E.C.; Oh, Y.I. Analysis of geotextile tube behaviour by large-scale field model tests. Geosynth. Int. 2003, 10, 134–141.
13. Driscoll, J.; Rupakheti, P.; Bhatia, S.K.; Khachan, M.M. Comparison of 1-D and 2-D Tests in Geotextile Dewatering Appl ications. Int. J. Geosynth. Ground Eng. 2016, 2, 2.
14. Huang, C.-C.; Luo, S.-Y. Dewatering of reservoir sediment slurry using woven geotextiles. Part I: Experimental results. Geosynth. Int. 2007, 14, 253–263.
15. Huang, C.-C.; Jatta, M.; Chuang, C.-C. Dewatering of reservoir sediment slurry using woven geotextiles. Part II: Analyti cal results. Geosynth. Int. 2012, 19, 93–105.
16. Satyamurthy, R.; Bhatia, S.K. Effect of polymer conditioning on dewatering characteristics of fine sediment slurry using geotextiles. Geosynth. Int. 2009, 16, 83–96.
17. Liao, K.; Bhatia, S.K. Geotextile Tube: Filtration Performace of woven geotextiles under pressure. North American Geo synthetic Conference. Presented at NAGS 2005/GRI 19 Cooperative Conference, Las Vegas, NV, USA, 14–16 Decem ber 2005; pp. 1–15.
18. Moo-Young, H.K.; Tucker, W.R. Evaluation of vacuum filtration testing for geotextile tubes. Geotext. Geomembr. 2002, 20, 191–212.
19. Queiroz, S.C.B. Influência das Características da Água Bruta no Desaguamento de Resíduos Gerados no Tratamento de Água Pela Filtração em Tubo Geotêxtil. Ph.D. Thesis, Universidade de Ribeirão Preto, Ribeirão Preto, SP, Brazil, 20 19.
20. Ratnayesuraj, C.R.; Bhatia, S.K. Testing and analytical modeling of two-dimensional geotextile tube dewatering proces s. Geosynth. Int. 2018, 25, 132–149.
21. GRI Test Method GT14:2004. Standard Test Method for Hanging Bag Test for Field Assessment of Fabrics Used for Ge otextile Tubes and Containers; Geosynthetics Research Institute: Folsom, CA, USA, 2004.
22. GRI Test Method GT15:2009. Standard Test Method for the Pillow Test for Test Field Assessment of Fabrics/Additives Used for Geotextile Bags, Containers and Tubes; Geosynthetics Research Institute: Folsom, CA, USA, 2009.
23. ASTM D7880:2013. Standard Test Method for Determining Flow Rate of Water and Suspended Solids Retention from a Closed Geosynthetic Bag; ASTM International: West Conshohocken, PA, USA, 2013.
24. Lawson, C. Geotextile containment for hydraulic and environmental engineering. Geosynth. Int. 2008, 15, 384–427.
25. Suits, L.D.; Sheahan, T.C.; Koerner, R.M.; Koerner, G.R. Performance Tests for the Selection of Fabrics and Additives When Used as Geotextile Bags, Containers, and Tubes. Geotech. Test. J. 2010, 33, 236–242.