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Operational outcomes of the first Teknobag-Draimad sludge dewatering technology installed in Brazil

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Highlights:

- First TEKNOBAG-DRAIMAD® permanently installed in Brazil to dewater sewage sludge from a small Wastewater Treatment Plant
- The dewatered sludge had an initial solids content of 8.3-10%, which quickly (10 days) reached 15%
- TEKNOBAG-DRAIMAD® filter bag had an efficiency of >99.9% in retaining sludge solids, allowing the production of a clarified with Chemical Oxygen Demand < 90 mg.L-1
- The dewatered sludge met class B biosolid requirements for application to soils, in accordance with brazilian legislation CONAMA 498/2020.

Keywords: sludge; dewatering; soil application

INTRODUCTION

Efficient dewatering of sewage sludge is a crucial step in sewage sludge management as it reduces sludge volume, which directly affects the costs associated with transport and disposal (Gonçalves *et al.* 2007). According to Miki *et al.* (2006) the most widely used sludge dewatering methods are drying beds, geobags, centrifuges, belt presses, and filter presses, noting that each technology carries its own characteristics, such as land requirements and costs of installation and maintenance. For small wastewater treatment plants, the standard and preferred option is drying beds, due to their low construction and operational costs, as well as their relative operational simplicity. However, their high land demand and odor issues make them unfeasible in many situations. Geobags represent an evolution of drying beds, addressing some of these issues, but they still require a relatively large area. In the present case study, the available space was extremely limited, making the use of geobags impossible. The Teknobag-Draimad® dewatering sludge system by ForzaZ is presented as a promising solution for smaller WWTPs. This compact, automated, and pressurized system features small filter bags for sludge dewatering and a polymer preparation unit, offering advantages such as minimal space requirements, operational simplicity and lower implementation and maintenance costs compared to traditional methods. This study examined the operation of the first Teknobag-Draimad® system for sludge dewatering at a WWTP permanently installed in Brazil, presenting the results from the initial three months of operation of this technology. The study was conducted on-site at the Nova Divineia WWTP, located in the municipality of São Fidelis-RJ-Brazil. The objective of this study was to assess the performance of the Teknobag-Draimad® dewatering system using real data obtained from the WWTP operation.

METHODOLOGY

The Nova Divineia WWTP consist of a sequential batch reactor process with aerobic sludge digestion, designed with a capacity of 3.5 L.s^{-1}. During the study period, it operated very close to this capacity. In the Teknobag-Draimad® system, digested sludge is pumped from an equalization tank into the system, where it receives the addition of polymer (2.25 g.L-1) in an in-line mixer, and is then injected into the filter bags with the aid of air provided by a blower. Solids are retained inside the bags and the clarified returns to the WWTP. The filled bags are then placed on pallets for an additional drying process until the bags are removed for final disposal. The nominal dewatering capacity of the Teknobag-Draimad® system is 120 kg TSS.d-1 (20 kg TSS.bag-1). The performance of the dewatering system was measured by the efficiency of retention of Total Suspended Solids (TSS) by the filter bags and by analyzing the solids content (%) of the sludge packed inside the filter bags subjected to different drying times on the pallets. For the analysis of TSS retention, TSS of incoming sludge and of the clarified leaving of the bags were measured. Parameters monitored in the study: TSS, Chemical Oxygen Demand (COD), dry matter, humidity and solids content, always following the standard methodologies (APHA, 2012). All analysis were carried out in duplicate. Furthermore, analysis of the sludge dried for 63 days were done for all parameters of the CONAMA 498/2020 legislation (which provides criteria and procedures for the production and application of sewage biosolids in soils in Brazil) and NBR 10004:2004 (which sets out the criteria for classifying solid waste in terms of dangerousness and inertia).

RESULTS AND CONCLUSIONS

At the end of a dewatering cycle in the Teknobag-Draimad® system, the sludge inside the bags reached a solid content of 8.3-9.9%. While lower than the solids content typically achieved by mechanized alternatives such as centrifuges and belt presses (13-20%) or filter presses (27-33%) (Gonçalves *et al.*, 2007), the dewatering process in the Teknobag-Draimad® continues beyond the cycle of the equipment, because the bags are laid out for drying by evaporation of moisture. As the moisture in the cake evaporates, there is an increase in solids concentration over time. This rise in solids content was most pronounced during the first 9 days of drying (Table 1), slowing down afterwards. Further analysis were then carried out to monitor the solids content within the same bag in the first 10 consecutive days (Table 2) and up to 40 days of drying (Table 3), which consistently confirmed this pattern of gradual moisture reduction.

Solid content (%)	Days drying
8,31	0
12,86	9
14,99	15
16,62	23
15,82	30
17,52	43
24,62	63

Table 1 – Relation between number of days drying and solid content inside the bags.

Solid content (%)	Days drying
9,97	0
10,08	1
10,93	2
11,38	3
12,25	4
12,98	5
11,71	6
13,05	7
12,59	8
13,18	9

Table 2 - Relation between number of days drying and solid content inside the same bag.

Solid content (%)	Days drying
8,31	0
15,75	10
14,23	20
16,37	30
19,78	40

Table 3 - Relation between number of days drying and solid content inside the same bag.

After the first 9 days of drying, the solids content reached 13-15%. With this content, landfill disposition is already viable. Therefore, in WWTP with severe area restrictions, it will be possible to dispose these bags after merely 9 days of drying, making room for new bags to dry. Despite this, the solids levels achieved were low: the maximum was 24.6% after 65 days of drying, when values up to 50% were expected. The way the bags were laid up, in horizontal pallets, may have contributed to the low solid content, as it limits the exposed surface area (Figure 1). Due to the outcomes of this study, a storage rack was recently built to improve the packaging of the bags (Figure 2) to try to make the reduction of moisture inside the bags faster.


Figure 1 - Filled bags placed on pallets


Figure 2 - Recently built storage rack

Regarding the retention of TSS in the bags, the efficiency was >99.9% (Table 4), while the clarified COD was less than 90 mg.L^{-1}, which attests to the efficiency of the bags as a solid separation technology. The sludge with 63 days of drying time did not show any parameters that indicate flammability, corrosivity, reactivity or toxicity, according to NBR 10004 (ABNT, 2004). Additionally, the value of *E.coli* was 764 MPN.g^{-1} solids, concentration of metals was always well below the maximum allowed, and volatile solids/total solids ratio was 0.20, while the requirement is to be lower than 0.65 (CONAMA 498/2020). These results classify the sludge robustly as a class B biosolid, class 1 subtype. It cannot be classified as a class A biosolid due to the presence of eggs and viable helminth larvae of 4.3g^{-1} ST, above the limit of 1.0 for class A. This is due to the absence of heat treatment of the sludge. Therefore, with the use of Teknobag-Draimad combined with simple drying of the bag, without any additional drying technology that would increase costs in a small WWTP, it is possible to obtain sludge that can be applied in soils for various applications.

	Sample 1		Sample 2		
Parameter	Incoming sludge	Clarified	Incoming sludge	Clarified	Removal efficiency by bags
COD (mgO_2.L^{-1})	13500	67	15420	88	99,5%
TSS (mg. L^{-1})	18680	10	23140	16,5	99,9%

Table 4 – Parameters monitored in incoming sludge and clarified (bag exit)

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