RECENT APPLICATIONS OF GEOTEXTILE TUBES FOR SLUDGE AND SLURRY DEWATERING – BRAZIL

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ABSTRACT

Nowadays one of the main environmental problems is the impact caused by waste, remains, by-products, materials and services. In addition, the residue from water and wastewater treatment plants or a liquid effluent generated during any production process, which damages may only be perceived long time after the inadequate disposal. In order to decrease the occurrence of inadequate disposal and such impacts, in Brazil, the National Environmental Council released in 2005 its 357th resolution, which has set the quality standards for effluents on superficial watercourses and classifies water bodies.
To attain the most recent law, and the new environmental preservation standards, some state and private companies are implementing, with exponential growth, slurry and sludge dewatering systems through geotextile tubes, as it's only or accessory system. This paper regards some of the Brazilian experience in geotextile dewatering tubes, presenting some applications, such as domestic wastewater, industrial wastewater and water treatment plants.

1. INTRODUCTION

In the past ten years Brazil has grown, economically and socially, in an accelerated rate. This increased production and consumption all around the country. Therefore the generation of fluid residue has also increased. Although the residue generated during water, wastewater, and industrial effluent treatment usually have high water content, the Brazilian standard for solid residues, ABNT NBR 10004:2004, classifies them as solid residue and forbids its disposal on the environment without treatment.

As a consequence of the disordered occupation of areas near of watercourses there is a decrease on water quality, therefore an increase on chemical coagulants consumption during water treatment procedures, which leads to a higher amount of residue to be disposed (ANDREOLI, 2001). It is a common practice in Brazil the lack of treatment of the water used for washing filters and also from the discharge of settlement units, the waste produced during the treatment process (LEME AND MERLIN, 2001).

Currently it exists a growing concern for the preservation of the environment around the world; the environmental awareness in Brazil has strengthened during the past two decades. This concern in Brazil arises from the creation of mechanisms of supervision and punishment on the part of the environmental agencies. In order to meet the pertinent legislation many public and private companies have performed dehydration of waste generated in the process of treatment of industrial effluents, water and waste water.

In order to decrease the pollution as a result of the incorrect disposal of the residue, reduce costs of adequate disposal and transport some private and State companies began to use geotextile tubes as an alternative dewatering solution.
The applications of geotextile tubes presented in this paper were performed during 2010 and 2011, always conducted by testing the dosage of polyelectrolyte solution needed to perform an appropriate dewatering method for each slurry or sludge, a cone test to assess the performance and interaction between geotextile and slurry or sludge, design of the geotextile tube cross section using GeoCOPS® program, followed by the full scale solution.

The dewatering of sludge and slurries generated in water and wastewater treatment plants as well as in industrial processes through geotextiles tubes has been worldwide applied with increasing tendency during the last decades. The following projects cases show the performance and the achieved efficiency of the solution:

2. UBERLÂNDIA

To control the overload of the system treatment in the wastewater Treatment Plant of Uberlândia, a city of the Minas Gerais State, the water and wastewater Municipal Department (DMAE) – installed a dewatering system compounded by SoilTain® geotextile tubes

Figure 1. Geotextile tubes at Uberabinha wastewater treatment plant

The geotextiles tubes installed had a length of 60m and a perimeter of 20 m. The tubes were designed according the requirements and properties of the domestic effluent produced in the plant (percentage of solids content by weight of 4%). The drainage bed (to collect the filtered water) was constituted by a flow control barrier (geomembrane), and a granular layer placed over a light non-woven geotextile.

Figure 2. Sludge dewatering

Figure 3. Cake removal for final disposal

After the last filling cycle, the geotextiles tubes remained dewatering for 90 days approximately, obtaining a residual dry material (cake) with very low water content (final percentage of solids content by weight of 28%). The consistency of this material after the dewatering process facilitated its transportation and its appropriate final disposal in a landfill.

Figure 4. Polymeric Unit (responsible for the adequate dosage and addition of the flocculate solution into the effluents conduction)

One of the success factors of the flocculation was the use of a cationic polyelectrolyte of high molecular weight, which was selected as a result of a rigorous set of laboratory tests, verifying important elements as the chemical affinity, the appropriate dosage and the stability of the flocs among others.

Figure 5. Drainage bed and geotextile tubes before filling

The drainage bed was designed to stock up two geotextiles tubes simultaneously, making possible a filling process by alternate cycles, compatible with the required flow rate of the project (30 a 40 m^3/h).

Figure 6. Geotextile tube during filling

In Brasil, the CONAMA – Environmental National Council– established allowable standards for the disposal of liquids effluents into hydrous bodies through the resolution 357/200. Consequently, all the filtered water was strictly monitored after the treatment, representing a cost-effective solution adjusted to the national legal requirements.
The Figure 8 indicates the filtration efficiency of the geotextile tube; measures were taken during the months of March and April of 2007. Samples were collected at intervals of eight hours, homogenized, and submitted to tests at the treatment unit's laboratory. According to Moo-Young e Tucker (2002), the filtration efficiency is the relation between total solids prior to the dewatering and the solids present in the percolated.

Figure 7. Reuse water

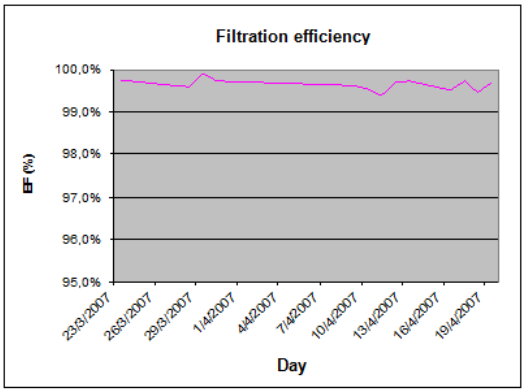

Figure 8. Filtration efficiency

The dewatering system through the geotextile tubes performed very well in terms of productivity and efficiency. The retention of solid particles and the filtration by using an adequate geotextile (high strength and permeability) generated a confined material with not only a low value of water content, but also a percolated product (filtered water) with very low levels of contamination (DQO/DBO values).

3. SANTO ANTÔNIO

Rondônia is located in the northern region of Brazil, has a population of about 1.5 million habitants, its capital, Porto Velho, is one of the cities in the country with most accelerated economical growth, which is directly related to the construction of two hydroelectric power plants, Jirau and Santo Antônio. Both power plants are located on the Madeira river complex, which will be capable of generating about 7.000 MW.
For the construction of the Santo Antônio hydroelectric power plant about 15.000 employees were hired, which also required the construction of infrastructure to provide the needs of those workers. The infrastructure included housing, medical and food facilities, and also water and wastewater treatment plants.
The project, since its begging, was focused on the preservation of the environment and reducing the environmental impacts to a minimum. Based on those goals, the contractor decided to use an alternative flocculant solution, an organic polymer made from black wattle bark instead of the traditional aluminum sulfate, which proved to be cost and technically effective (CANTIERI, 2011). Since the polymer is organic and does not have high concentrations of heavy metals in its chemical composition the slurry generated during the water treatment processes could be used for rehabilitation of degraded areas as a result of heavy machinery load from the hydroelectric power plant construction.
In order the reduce volume, costs and environmental impacts due to the slurry transportation to the degraded areas the contractor decided to use a dewatering system based on geotextile tubes, ranging from 5,00m to 10,00m of cross section perimeter and 18,00m to 25,00m meters in length, according to the water treatment capabilities of each plant (from 20 to 200 m^3/h) and available area. The tubes contain slurry from the settlement and filtration units in all water treatment plants. The water that flows through the geotextile tubes is collected and then recycled or reutilized.
The closed circuit ecological water treatment plant was able to reduce:

- polymer consumption,
- environmental impacts due to the non heavy metal based flocculants,
- water consumption trough reutilization of the water present on the high moisture slurry

Figure 9. Geotextile tubes at hydroelectric power plant Santo Antônio

4. PIQUETE

Piquete is a small town in the country side of Sao Paulo State, with a population of approximately 14.000 habitants. Its water treatment plant is capable of treating 320 m³ per hour, and there was an environmental liability there when CAB (a Brazilian water company) started its concession contract.

Sediments were building up within the floculator and settlement unit, the contractor needed them to clean up those units in order to increase the treatment plant efficiency, and also to solve this environmental liability. As a consequence, the contractor had to remove that material and give it a proper final disposal. In order to reduce the volume of the sediments that had to be transported, they decided to dewater them.

The solution adopted by the contractor to dewater the slurry achieving the desired 25% minimum solids ratio of the cake in order to reduce the transportation and final disposal costs (REALLI, 1999), was to dewater it through geotextile tubes. The material that was to be contained within the geotextile tubes did not need any chemical conditioning, such as addition of polyelectrolyte solution, to create a filter cake capable of retaining the fine grained particles of the slurry. This was achieved through the utilization of a 200µm characteristic opening size (ISO 12236) woven geotextile. The sediments that had built up in the floculator were composed mainly by medium grained sand, not the usual material for dewatering applications.

The material that was built up in the settlement unit was composed by a fine grained material, non-plastic silt, with liquid limit of 112% , after two months, measures indicates that the water content of the cake was 65%, about 10% less water than the expected for this material. The material that built up in the floculator unit was basically a medium grained sand, a fairly easy to dewater material. The Figure 11 shows the particle size distribution for both materials.

Figure 10. Floculator unit

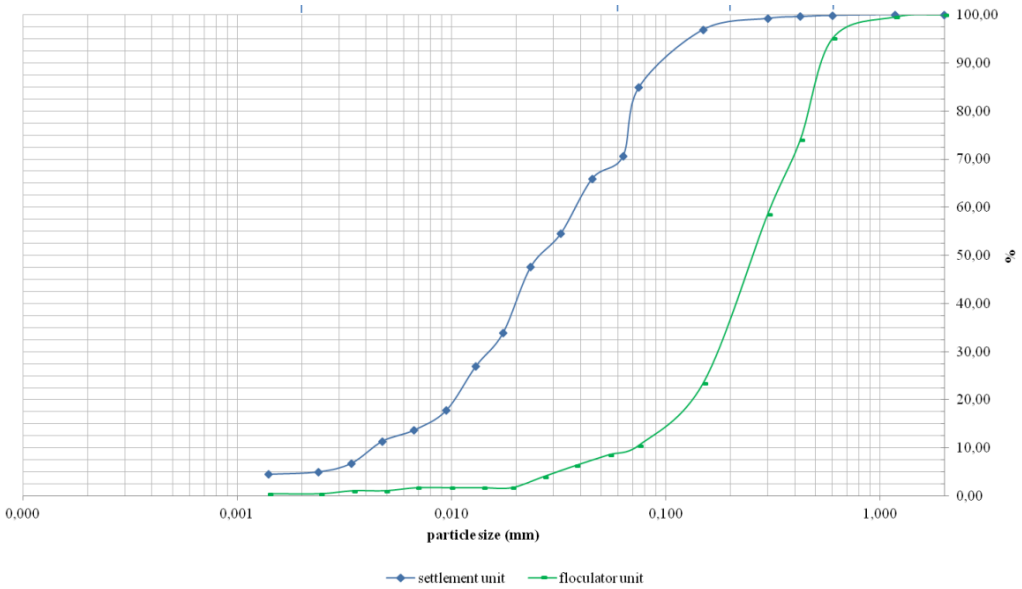

Figure 11. Particle size distribution

The tubes were capable of containing 17.50 m³ of cake each, with a combined containment capacity of 35.00 m³. They were manufactured with HaTe® 80/80 woven geotextile, which has an ultimate tensile strength of 80kN/m in both the machine and cross-machine direction (ISO 10319).

The cone test indicated that the slurry could be dewatered without the need of any chemical conditioning, capable of producing a filter cake without the occurrence of clogs or blockage of the geotextile. The system was able to contain the heavy metals in accordance with the current legislation, without leaching of suspended solids.
This solution reduced the environmental damages that could occur if this slurry was disposed without any treatment in watercourses, since the aluminum and iron concentrations were above the limits allowed by Brazilian legislation.


Figure 12. Filling of the geotextile tube

5. FINAL CONSIDERATIONS

Geotextile tubes are a feasible solution for dewatering slurries and sludge, from water, wastewater and industrial effluents treatments plants, with high filtration efficiency (Figure 8). The experience indicates that the systems is capable of reducing water content of such residues while containing a great portion of solids.

Cone tests can give good insight about the future geotextile tube performance; in some particular cases the dewatering can be performed without chemical conditioning, the experience shows that this is not the usual procedure for dewatering.

In water treatment plants, the association of organic polymers used as flocculants and geotextile tubes for dewatering can reduce chemical products consumption, environmental impacts due to inadequate disposal of slurries with high concentration of heavy metals.

The chemical conditioning, necessity of a flocculant solution, should be evaluated according to the particle size distribution, nature and percentage of solids present in the residue to be dewatered. This study is of great importance for the performance of the entire dewatering system. The solution used for the chemical conditioning can interact or not with the particles, creating bigger particles that can be retained by the geotextile.

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