The use of Geotextile Tube Technology to Contain and Dewater Sewage Sludge from a Separator Unit at Ecopetrol's Refinery in Barrancabermeja, Colombia, S.A.

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ABSTRACT
The separator units at the refinery, in addition to receiving storm water, waste from the industrial area also converges as "fresh" catalysts of the cracking unit, which, according to reports from the refinery operation, presents problems in the loading process of the hoppers, as well as sludge of the water treatment plants, by dragging or disposing of the process units to the stormwater systems.
The objective of the project was to remove the sludge that had accumulated in the separator unit in the least possible time, allowing the cleaning operation to recycle and reused all water resulting from the dewatering process within the process and to safely remove the dewatered solids upon completion of the project. To accomplish these goals, Geotextile Tubes were selected as the main dewatering system. Over 30.000m^3 of sludge were pumped into 6 Geotextile Tubes using a hydraulic sludge pump, ranging from 27m to 36 in circumference and 30m long. Combined, a little over 6.800m^3 of dewatered solids were hauled by truck, which means a volume reduction of 78% was achieved.
Geotextile Tubes proved their convenience and excellent performance in dewatering sludge with traces of crude oil and grease and have become the number one option for cleaning, solids removal, dewatering no matter what the conditions are, rain or shine.

1. INTRODUCTION

1.1 Project Background

The Barranca refinery in Colombia, began operations 97 years ago with an installed capacity to process 1500bls/day of crude oil. Over the past decade, Ecopetrol has invested over six billion dollars upgrading its infrastructure to process cleaner fuels. Today, the refinery can process up to 250.000bls/day.

1.2 Separator SE3090

Separator SE3090 chamber is made of 4 different sections: a. pre-separator, b. charging chamber, c. separator chambers 3090 A & B, as shown in Figure 1. The Separator's main purpose is to collect all storm water, as well as industrial residues as fresh catalysts from the cracking unit.

Figure 1. Separator SE3090

1.3 The Challenge

As the Separator collects storm and industrial waters, it fills up as solids are deposited and quickly loses hydraulic capacity. During previous clean-up operations, this sludge would be removed by excavator, often spread on the field to allow for water evaporation and eventually, more than 70 laborers were required to transfer sludge into plastic drums and hauled away to a landfill. This operation takes at least 90 days and proved to be not only expensive but also very inefficient, as it was removed with high water content.

The challenge was to deliver a clean Separator structure by mechanically pumping this sludge into Geotextile Tubes, dewater it and return the clean effluent back to the chamber, while it was operational.

Figure 2 – Site Condition and Samples

2. FIELD TESTS AND PRELIMINARY RESULTS

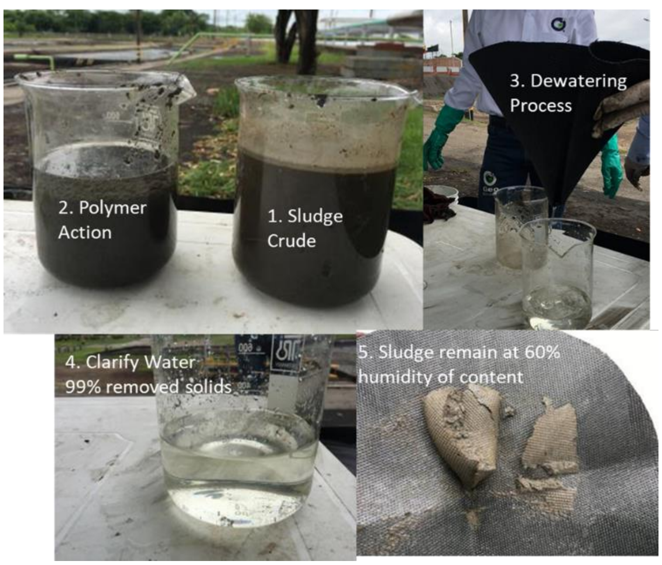
2.1 Field Tests

Back in April 2017, a series of field tests were conducted to determine the feasibility of using Geotextile Tubes to dewater sludge from the Separator unit at the refinery. Four Cone Tests (CT) and one Geotextile tube Dewatering Test (GDT) were carried out with sludge from the pre-charge Chamber, Separation Chamber 3090A using a non-ionic polymer at different dosages.

2.2 Test Results

2.2.1 Cone Test

Main purpose for carrying out Cone Tests is to determine the correct polymer conditioning and dosage. In this case, a non- Ionic polymer (70 PPM) was used and prove to yield the best results for flocculating solids and optimal effluent quality, as shown in Figure 3



		TEST #1	TEST #2	TEST #3
1. Sludge Volume				
Sludge	ml	750	750	750
2.Polymer Volume				
Type	N/A	Anionico	No Ionic	No Ionic
Comercial Name	N/A	Praestol 50004	2500	2500
3.Dosage Volume				
Polymer	ml	20	15	10
Concentration (Parts Per Million)	PPM	**133**	**100**	**67**
4. Clarify Volume				
Liquid clarify	ml	150	350	450
Time	Min	2.5	2	1.1
5. End Humidity				
Amount of Clarify	ml	150	350	450
% of Humidity	%	**20%**	**47%**	**60%**

Figure 3 – Cone Test Results

2.2.2 Geotextile Tube Dewatering Test, GDT

The Geotextile Tube Dewatering Test (GDT) is carried out immediately after the Cone Test achieves the desire dewatering results. A 50-liter sample of conditioned sludge is poured into a Geotextile Tube Dewatering Bag and allowed to dewater. Solids from the bag are cut out and tested for dry solids, to establish the percent dewatered solids the sample will achieve over time, usually 7, 14 & 21 days. Percent Dewatered solids will become input data for our Geotextile Tube Design. Figure 4 – Geotextile Tube Dewatering Test.

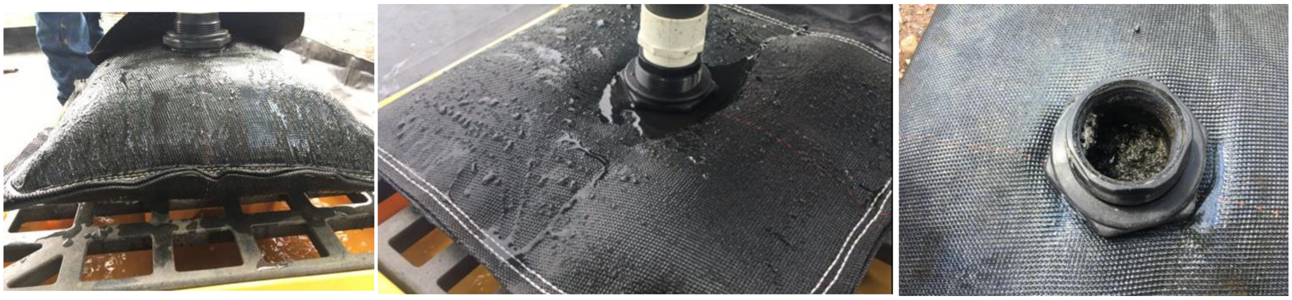
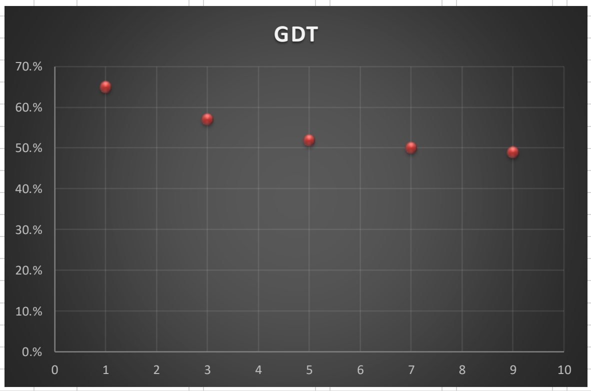


Figure 4 – Geotextile Tube Dewatering Test

		Day 0	Day 7	Day 15	Day 21	Day 30
5. End Humidity						
% of Humidity	%	65%	57%	52%	50%	49%



3. GEOTEXTILE TUBE DIMENSIONING

Once field tests are analyzed and the sludge has been characterized, project planning may continue and will include but not be limited to: Geotextile Tube Dimensioning, pumping equipment system, polymer conditioning and mixing units, feed lines and manifolds must all be designed so that every piece becomes a part of an integer system. Space available on site will set the parameter for designing the Geotextile Tubes. In this case, the project utilized 1 unit 36.56m in circumference x 30.48m long (120'x100' unit) and 5 units 27.0m in circumference x 30.48m long (90'x100' unit), which were filled at intervals to allow for a complete filling and dewatering of all Geotextile Tube units. Geotextile Tubes are fabricated from a specifically engineered polypropylene geotextile to allow for high mechanical as well as hydraulic properties. Geotextile Tube Estimator and Simulator Design tools were used on this project.

Each Geotextile Tube was filled to a design height of 2.45m and dewatered to an average height of 2.20m, containing over 1,100m^3 of dewatered solids. Geotextile Tubes were placed on a dewatering cell to allow for dewatering, effluent was collected and returned to the Separator Unit with a solids removal of over 99%. Figure 5 – Dewatering Cell, shows the layout used for all Geotextile Tubes used in the project.

Figure 5 – Dewatering Cell

Figure 6 – Layout of the Process

4. RESULTS AND CONCLUSIONS

The Separator Chamber was cleaned in record time (30 days) and the use of Geotextile Tube Dewatering Technology proved to be the best alternative for the removal and dewatering of sludge. It was a cost reduction (35%) and time reduction (90 days to 30 days). The field team consisted of 7 people in total. A reduction of volume of approximately 78% was achieved making the disposal process easy and more economical and environmentally friendly. Also, quality of the effluent that was returned and reused within the process to the Separator Chamber had a 99% solids removal and most importantly, the chamber was cleaned without requiring a plant shutdown and the facility was always fully operational. Figure 7 – Before and After Separator Chamber SE3090, shows before and after photos from the Chamber.

a) Separator SE3090 – Before

b) Separator SE3090 - After

Figure 7 – Before and After Separator Chamber SE3090

REFERENCES

Stephens, T. (2013). Beneficial Use of Dredged Contaminated Sediments Using Geotextile Tube Technology, WEDA 33, Honolulu, HI, USA