Report on Piloting of the Volute Dewatering Press at the Boonsboro WWTP in Boonsboro, MD

July 25th- July 29th, 2016

PWTech
PROCESS WASTEWATER TECHNOLOGIES LLC

Process Wastewater Technologies, LLC.
9004 Yellow Brick Road, Suite D, Rosedale, MD21237
Phone: 410-238-7977, Fax: 410-238-7559

Pilot Operator:	David Lichtenberger
Report Prepared by:	David Lichtenberger
Manufacturer’s Representative:	Dwight Swan, Envirep

Summary

- Pilot testing of the ES132 trailer mounted Volute Dewatering Press was undertaken at the Boonsboro WWTP in Boonsboro, MD on the plant’s aerobically digested sludge during the week of July 25th.

- Cake solids up to 23.9% were recorded dewatering a sludge that averaged 0.63% solids.

- Solids recovery up to 99.1% were observed, averaging 90.4%.

Contents

1. Introduction

The Volute Dewatering Press ES132 Trailer mounted unit was used to perform a pilot study on the aerobically digested sludge at the Boonsboro Wastewater Treatment Plant (WWTP) in Boonsboro, MD on the week of July 25th, 2016.

Following the plant's headworks which consist of bar screening and grit removal, influent wastewater is treated in a Sequential Batch Rector (SBR). Effluent from the SBR is filtered and chlorinated before being discharged into the local creek. Sludge from the SBR is pumped to a holding tank where it is thickened before being hauled off site via a tanker truck at approximately 2% solids. A basic flow diagram of the process is shown below in Figure 1.

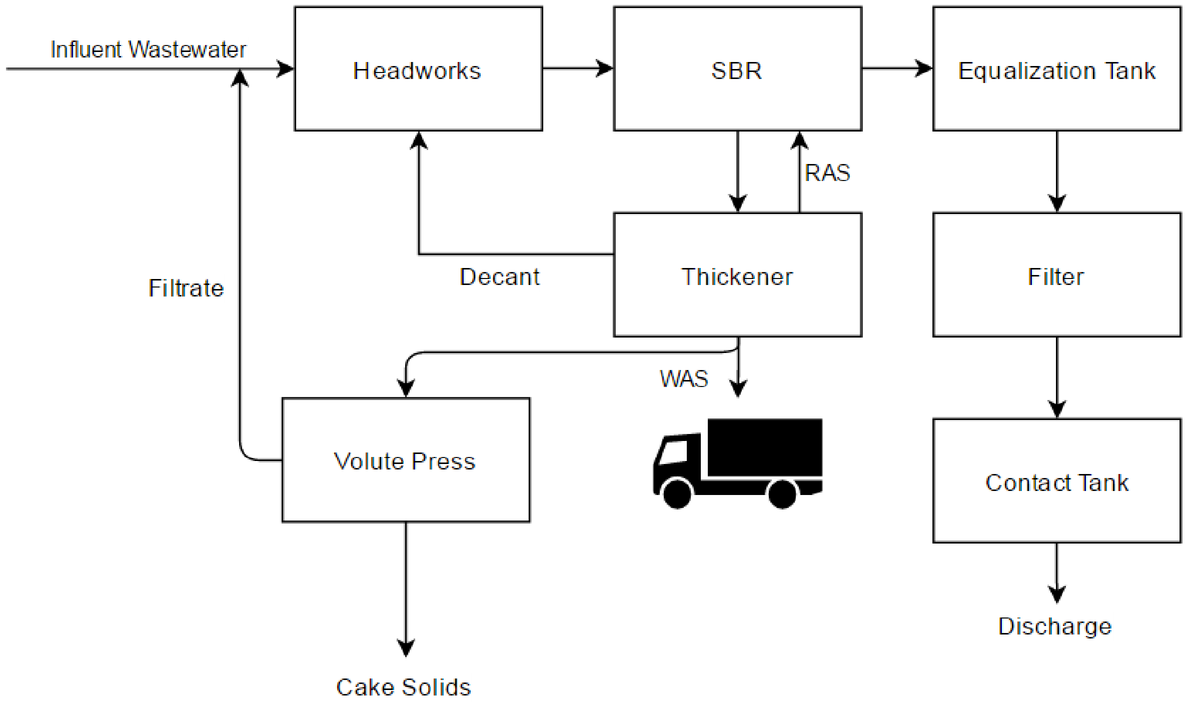

Figure 1: Brief overview of the Boonsboro WWTP treatment process including the position of the Volute pilot.

A dewatering unit will allow for the plant to significantly reduce the volume of material being hauled off.

2. Objective

The pilot study aims to demonstrate the capabilities of the Volute Dewatering Press in dewatering the plants aerobically digested sludge. The study highlights several of the benefits associated with the Volute Dewatering Press technology, while the accompanying data provides a guide for sizing a potential Volute Press for this plant.

3. Pilot Set-up

The ES132 trailer mounted pilot unit was setup adjacent to the plants thickener and next to a covered dumpster for cake solids. The sludge was pumped from the thickener to the pilot unit, and the flow rate into the pilot unit was controlled using a progressive cavity pump. The cake solids produced were collected in a covered dumpster, while filtrate was gravity fed back to the headworks of the plant.

4. Testing and Sample Analysis

After the unit was started and operating smoothly, the process of finding the optimal conditions began. Parameters under the operator’s control were changed to determine the operating conditions that produced the driest cake solids at the lowest cost.

Controllable Parameters:

- Feed sludge flow rate
- Endplate gap – the gap between the rotating plate and the end of the dewatering drum through which the cake is discharged.
- Screw speed – rotational speed of screw in dewatering drum.
- Polymer type –Ashland Praestol k275 FLX, and Ciba Zetag 8848 were tested.
- Polymer dose

In order to determine the effectiveness of the unit, samples were taken one hour after making changes to the operating parameters and analyzed. These samples included:

- Feed solids – measured as total residual solids (TS) in percent [% $^{w}/_{w}$]
- Cake solids – measured as total residual solids (TS) in percent [% $^{w}/_{w}$]
- Pressate solids – measured as total suspended solids (TSS) in mg/L

Feed and cake solids tests were done on site using a Sartorius Moisture Analyzer, which measures the cake solids concentration to 0.1%. It functions by recording the initial weight of the sample, heating it until the change in weight drops below -1 mg per 60 seconds, and then recording the final “dry” weight. The total % solids are then calculate using Formula 1 below.

$$Total\ \%\ Solids = 100 * \left(\frac{A}{B}\right)$$

Formula 1: A is the weight of the dry sample and B is the weight of the wet sample.

Pressate samples were taken from the end of the pressate hose and sent to a local laboratory for TSS analysis. This is because this is a more precise laboratory procedure than the total solids analysis and is best done in a proper laboratory rather than on the bench of a trailer where vibrations, swaying due to wind and other factors would render the results inaccurate at best.

The polymers supplied by PWTech were cationic emulsion polymers. Specifically, Ashland Praestol k275 FLX (43% active) and Ciba 8848 (39% active) were used for this pilot. The polymer activation system mounted on the trailer blended the raw polymer in the containers with water to create a solution which is then introduced to the sludge line to achieve flocculation.

5. Results and Discussion

The ES132 pilot unit was onsite for a total of 4 days during which time it was able to conduct 18 distinct “runs”. Each run consisted of at least an hour of continuous dewatering using specific operational conditions, and the details for each run can be found in the appendix of this report.

5.1. Influent Sludge

The aerobically digested sludge averaged a solids concentration of 0.63%, with fluctuations up to 0.17% between runs. These fluctuations have no impact on the operation of the press or its performance and result in only minor unintended fluctuations in the calculated throughput and polymer dose.

5.2. Cake Solids

Cake solids reaching 23.9% were observed while cake solids for the entire study averaged 18.9%. The cake solids achieved in each run are shown in Figure 2.

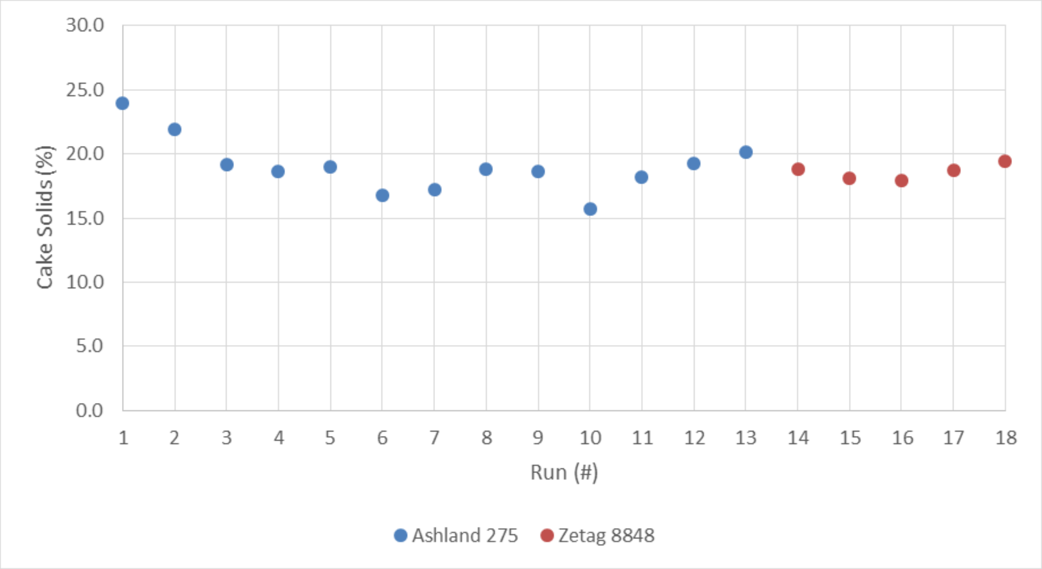

Figure 2: Cake solids for each run performed.

It was observed that the cake solids generated by the Volute Press were affected slightly by the polymer dose and the solids throughput also had a minor effect. In order to understand the relationship between the cake solids and amount of polymer used, a series of runs were performed at near identical conditions with the exception of the polymer dose. A direct relationship between polymer dose and cake solids was observed, as illustrated in Figure 3 below.

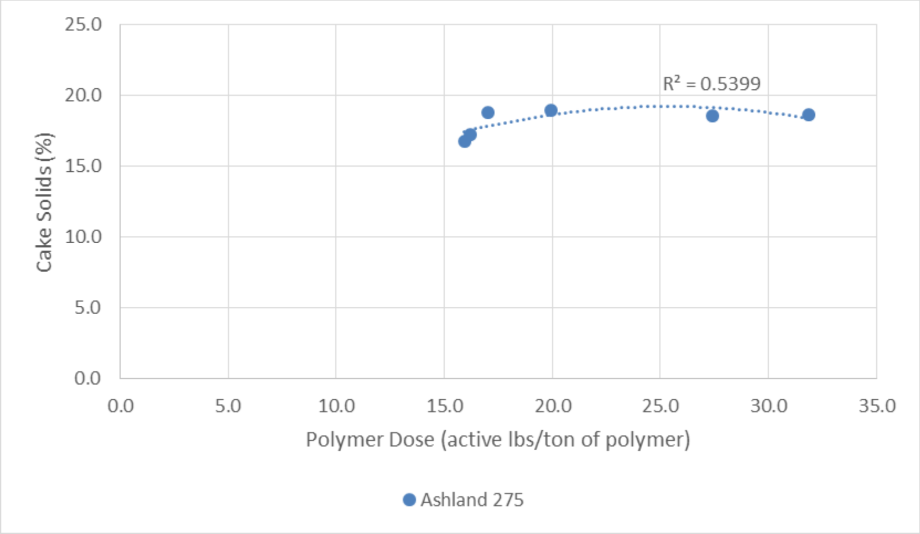

Figure 3: Effect of polymer dose on cake solids.

In addition to the polymer dose used, it was also found that solids throughput had a minor influence on cake solids. As solids input to the unit increases, the speed of the screw rotation needs to be increased in order to maintain a steady throughput of solids. This increase in screw speed leads to a decrease in dewatering time, and therefore cake solids.

To quantify this decrease, a number of runs were performed with near identical conditions with the exception of the solids throughput. Cake solids were found to decrease by approximately 4% while increasing throughput from 20% to 75% of the units stated capacity. Figure 4 below shows the extent to which increasing the throughput affected the cake solid.

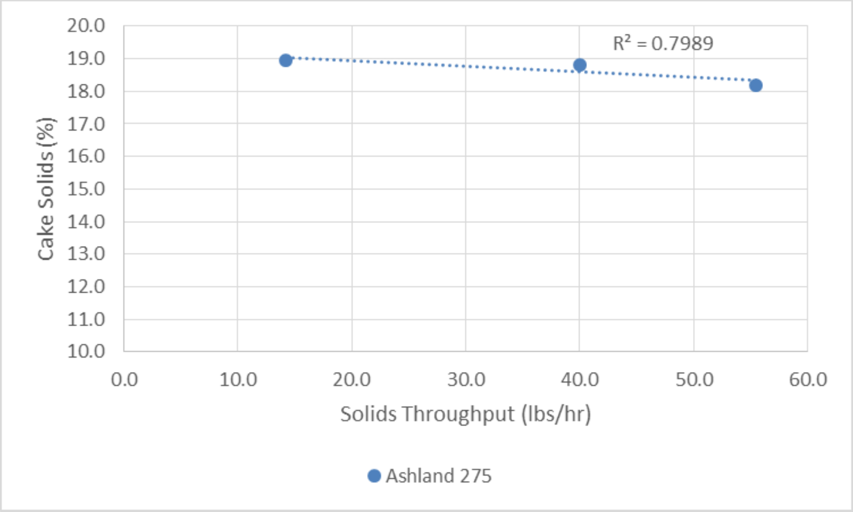

Figure 4: Effect of solids throughput on cake solids.

5.3. Polymer Use

Throughout the course of the pilot, two different polymers as well as a range of polymer doses were tested to determine the effect of these differences in the resulting cake solids. It was observed that the different polymer achieved fairly similar cake solids, with rather small increases or decreases at similar doses. The effect of polymer on cakes solids is shown below in Figure 5.

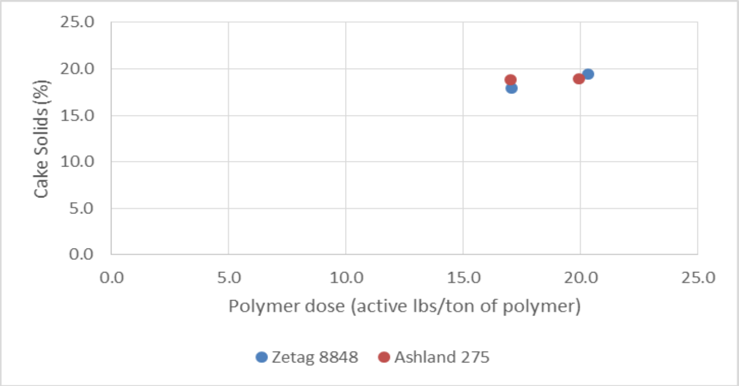

Figure 5: Effect of polymer dose on dewatering performance.

The minimum effective polymer dose for each polymer was experimentally determined by slolwy decreasing the polymer dose unitl the floc was observed to be lost. The minimum effective polymer doses represents the dose at which point any decreases in polymer will result in significant losses in both cake solids and solids capture. It was found that both polymers were able to dewater the anaerobically digested sludge with doses as low as approximately 15 lbs/ton.

5.4. Solids Capture

Pressate samples were collected and sent to a lab for TSS analysis for all runs, which was used to calculate the % of solid recovered. The solids capture reached 99.1% and results averaged 90.4% for the entire pilot. These results were achieved under numerous and varied run conditions and it can be inferred that similar results should be observed in a full scale application. Figure 6 shows the solids capture % for all analyzed runs.

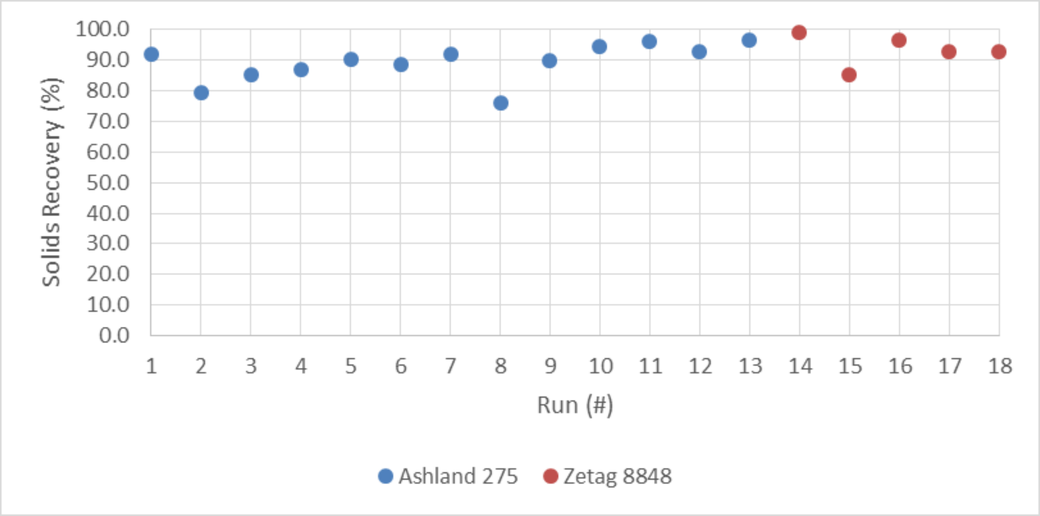

Figure 6: Solids recovery observed for all runs collected.

6. Conclusion

The Volute Dewatering Press model ES132 trailer mounted unit was used to perform a pilot study on the aerobically digested sludge at the Boonsboro WWTP on the week of July 25th, 2016.

While dewatering the aerobically digested sludge, cake solids of up to 23.9% were achieved with solids capture of up to 99.1%.

It was found that cake solids of approximately 19% were achieved with a polymer dose of 17 lbs/ton.

7. Acknowledgments

PWTech would like to thank Pete Shumaker and the Boonsboro WWTP staff for their assistance in the operation of this pilot study.

PWTech
PROCESS WASTEWATER TECHNOLOGIES LLC

Appendix –All Results

Run		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Date		7/26/2016	7/27/2016							7/28/2016								7/29/2016	
Unit Parameters																			
Endplate gap	**[mm]**	2	2	2	2	2	2	2.2	2.2	2.2	3	2.4	2	2	2	2	2	2	2
Drum Screw Speed	**[RPM]**	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Flocculation Mixer Speed	**[RPM]**	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Flow	**[gpm]**	5	5	5	5	5	5	10	10	10	20	15	8	8	8	8	8	8	8
Chemical Dosing																			
Polymer		Ashland 275													Zetag 8848				
Raw Polymer Flow	**[mL/min]**	11	8	6	4	2.5	2	5	6	7	11	8.5	8	8	8	6.5	4.5	3.25	4.5
Percent Active	**[%]**	43	43	43	43	43	43	43	43	43	43	43	43	43	39	39	39	39	39
Cost Per pound	**[$]**	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	0.88	0.88	0.88	0.88	0.88
Active Polymer Dose Rate	**[ppm]**	208	151	114	76	47	38	52	62	72	60	60	101	101	92	74	52	37	52
Solids Concentration																			
Influent Solids	**[%]**	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.8	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6
Cake Solids	**[%]**	23.9	21.9	19.2	18.7	19.0	16.8	17.3	18.8	18.6	15.7	18.2	19.2	20.2	18.8	18.1	17.9	18.8	19.4
Pressate Solids	**[mg/L]**	430	1100	800	740	540	650	560	1900	590	310	280	490	250	64	1000	220	410	410
Calculated Parameters																			
Solids Throughput	**[#/hour]**	13	13	13	14	14	14	35	40	29	58	55	28	29	29	27	27	23	23
Solids Capture	**[%]**	91.9	79.2	85.2	87.0	90.5	88.6	92.0	76.3	89.8	94.7	96.2	92.9	96.6	99.1	85.3	96.8	92.8	92.8
Active Polymer Use	**[lbs/ton]**	94	69	50	32	20	16	16	17	27	22	17	33	31	28	25	17	15	20
Polymer Cost																			
Total Cost per Ton	**[$]**	291	212	156	99	62	49	50	53	85	67	54	102	96	64	56	38	33	46

Table 1: Results

Appendix -Table 1 Calculations Expanded

Active Polymer Use relates polymer used to solids generated. It is the ratio of active polymer used to solids throughput, and is commonly calculated as pounds of active polymer per dry ton of solids. In order to show this calculation, solids throughput and active polymer flowrate are calculated first. Sludge is assumed to have a specific gravity of 1.

Solids Throughput: calculated for one hour.

$$Sludge\ Flowrate\ (gpm) * 60\ \frac{min}{hour} * 8.35\ \frac{lb}{gallon} = pounds\ of\ sludge\ per\ hour$$

$$\frac{influent\ solids\ \%}{100} * \frac{lbs\ of\ sludge}{hour} = lbs\ of\ solids\ per\ hour$$

Active Polymer Flow for one hour is calculated from Raw Polymer Flow:

$$\frac{mLs\ of\ raw\ polymer}{minute} * 60\ \frac{min}{hr} * \frac{\%\ active}{100} * .0022\ \frac{lbs}{mL} = lbs\ of\ active\ polymer\ per\ hour$$

Active Polymer Use is the ratio of Active Polymer Flow to Solids Throughput:

$$\frac{lbs\ of\ active\ polymer\ per\ hour}{lbs\ of\ solids\ per\ hour} * 2000\frac{lbs}{ton} = lbs\ of\ active\ polymer\ per\ dry\ ton\ of\ solids$$

Polymer Cost per Ton of Solids is calculated from Active Polymer Use and Solids Throughput:

$$\frac{lbs\ of\ active\ polymer}{dry\ ton\ of\ solids} / \frac{\%\ active}{100} = lbs\ of\ raw\ polymer\ per\ dry\ ton\ of\ solids$$

$$\frac{lbs\ of\ raw\ polymer}{dry\ ton\ of\ solids} * \frac{\$}{lbs\ of\ raw\ polymer} = \$\ per\ dry\ ton\ of\ solids$$

Example calculations for run # 4:

Note: Numbers in the spreadsheet are rounded to the nearest tenth place and nearest integer to keep it neat and easily readable. Numbers may vary slightly from the example calculations below.

Solids throughput:

$$5\ gpm\ *\ \ 60\ \frac{min}{hr}\ *\ 8.35\ \frac{lb}{gallon} = 2505\ \ lbs\ of\ sludge\ per\ hour$$

$$\frac{0.57\%}{100} * \frac{2505lbs}{hour}\ = 14.27\ lbs\ of\ solids\ per\ hour$$

Active Polymer Flow for one hour is calculated from Raw Polymer Flow:

$$\frac{4\ mLs}{minute}\ *\ 60\ \frac{min}{hr}\ *\ \frac{43\%}{100}\ *\ .0022\ \frac{lbs}{mL}\ = 0.227\ lbs\ per\ hour$$

Active Polymer Use is the ratio of Active Polymer Flow to Solids Throughput:

$$\frac{0.227\ lbs\ polymer}{14.27\ lbs\ solids} *\ 2000\frac{lbs}{ton} = 31.8\ lbs\ of\ active\ polymer\ per\ dry\ ton\ of\ solids$$

Polymer Cost per Ton of Solids is calculated from Active Polymer Use and Solids Throughput:

$$\frac{31.8\ lbs}{dry\ ton\ of\ solids}\ /\ \frac{43\%}{100} = 73.9\ lbs\ of\ raw\ polymer\ per\ dry\ ton\ of\ solids$$

$$\frac{73.9\ lbs\ of\ raw\ polymer}{dry\ ton\ of\ solids}\ *\ \frac{\$\ 1.33}{lbs\ of\ raw\ polymer} = \$\ 98.36\ per\ dry\ ton\ of\ solids$$