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Anaerobic & Aerobic Solids Thickening:
CASE STUDY

Heron Innovators May-June 2010 Pilot Testing
Synagro Organic Fertilizer Co. of Sacramento

SUSPENDED AIR™ FLOTATION AND CENTRIFUGE PILOT TESTING REPORT

This report was prepared by Heron Innovators on 7/16/10, with input from Synagro (P. Santos) and Ashland (M. Wells).

Testing was conducted at the Synagro Biosolids Recycling Facility, 8600 Laguna Station Rd., Elk Grove, CA 95758 over the period 5/18/10 through 6/4/10.

Heron Innovators placed its Suspended Air™ Flotation (SAF™) Pilot Trailer No. 3 at Synagro in May and early June 2010 for a test of flotation thickening and centrifuge dewatering of digested sludge received by Synagro from the Sacramento Regional Wastewater Treatment Plant (SRWTP), a test of flotation thickening and centrifuge dewatering of Waste Activated Sludge obtained from SRWTP, and a test of heat treating and centrifuge dewatering of thickened Waste Activated Sludge.

Summary of Digested Sludge Results (May – June 2010)

On digested sludge, the Heron SAF™ process was successful at thickening from approximately 1.2 – 1.6% solids content to between 3.5 and 5.3% solids content, with polymer dosages between about 13.5 and 16 lb. per dry ton with no dilution water required. Sludge hydraulic loading rates were between about 2.9 to 5.7 gpm per sq. ft. Slower skimmer speeds were correlated with higher thickened sludge solids content. Flotation produced low-TSS underflow at solids loading rates anywhere in the range of 22 to 46 lb/hr per sq. ft. Air:solids ratios were less than 0.5%.

The thickened digested sludge produced by SAF™ flotation was able to be dewatered in the Centrisys 16" centrifuge to the same solids percentage as in the full-size centrifuge, with polymer dosages similar to those used currently at Synagro. There was no observable adverse effect on centrifuge dewatering due to the use of the Heron frothing agent for thickening.

During well-controlled testing on digested sludge, a total polymer consumption of 34 lb/dry ton through thickening and dewatering was measured. This is significantly less than the approximately 44 lb/dry ton used at Synagro according to the plant.

Use of a lower charge density polymer for thickening digested sludge produced the same results as from use of the high molecular weight, high charge density polymer in use currently at Synagro, based on testing using Ciba dry polymers conducted on 6/2/10 and using Ashland emulsion polymers conducted on 6/3/10. There may be an opportunity for operating cost savings if the lower-cost polymer were to be used for thickening.

The Ashland representative (M. Wells) observed that digested sludge thickened by the SAF™ responded well to a variety of different polymers, not just one or two as had been observed numerous times in the past with the SRWTP digested sludge.

Summary of Waste Activated Sludge Results (May – June 2010)

Return Activated Sludge (RAS), equivalent to Waste Activated Sludge (WAS), was collected on 5/25/10 and again on 6/3/10. High charge density / high molecular weight polymer was used for thickening in both cases. Polymer consumption through centrifuge dewatering was somewhat higher than for digested sludge. High capture rates and adequate thickened sludge solids were achieved in both cases. Operation of the SAF™ was satisfactory at solids loading rates greater than Heron's

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catalog rating of 15 lb/hr/sq. ft. It is expected that significantly lower polymer dosage for thickening will be possible using a polymer closer in characteristic to that used by SRWTP in their gravity belt thickeners.

Centrifuge dewatering results from the 5/25/10 run were as expected for WAS, with 18.5% solids measured by the plant. When thickened WAS was heated to greater than 115 °F for over 3.5 hr., the dewaterability improved markedly, dewatered solids measuring 25% and greater, similar to digested sludge, with the same or less polymer consumption as for un-treated WAS. Mechanical consistency of the dewatered product mixed with dry pellets was observed to be acceptable for drying.

Pilot Testing Setup

Equipment provided by Heron included the following:

- Control panel with various VFD's and starters re-purposed at various times during the trial to power equipment.
- 7.5-Hp self-priming transfer pump, relocated to mixing tank area.
- 4" magnetic flow meter, relocated to transfer pump discharge.
- Model CF-125 ClearFloater™ flotation tank with flocculation mixer, skimmer, and dual 2" inlets with connections for Suspended Air™ Emulsion.
- Conditioning tank with two turbine agitators, used for holding thickened sludge until 5/27/10.
- Sigma mechanical diaphragm polymer metering pumps, one with 264 gallons per hour max. capacity for made-down dry polymer feed, and one with 1.1 gph max. capacity for neat emulsion polymer feed to Polymixer.
- Polymixer Model 100 polymer makedown system for dilution and activation of polymer feed with up to 3 gpm of dilution water.
- Model F50 Suspended Air™ Emulsion Generator with control panel, frothing agent metering pump, recycle pump, and emulsion output flow meter.

Equipment and facilities provided by Synagro included the following:

- The Vulcan step screen for removal of inorganic material from digested sludge.
- The 120,000 gallon mechanically agitated digested sludge receiving / equalization tank.
- A 25-Hp 6" Vogelsang lobe pump transferring thickened sludge.
- A 20,000-gallon portable waste activated sludge holding tank with four 25-Hp turbine agitators.
- Polymer solution supplied from the plant's 6,000-gallon aging tank.
- Two variable speed dynamic mixers with polymer inlet ports, 4" and 6" size.
- A 6" air-operated pinch valve.
- A temporary tote container and dry polymer makedown system used for some of the thickening and centrifuge runs.
- A 1,000-gallon agitated tank relocated from the GBT test area, for digested sludge holding during runs after 5/26/10.
- A 16" Centrisys centrifuge package complete with progressing cavity feed pump and Veloblend polymer makedown system.
- Dual 2" Vogelsang pumps, a 1,900-gal. insulated polyethylene tank, a shell-and-tube heat exchanger, and connecting piping for heating thickened waste activated sludge.

- Pressurized SRWTP secondary effluent for polymer makedown, tank flushing, and Suspended Air™ Emulsion generator feed.
- Electrical power supply.
- Hose connections for digested sludge, water, underflow drain, and thickened sludge.

Pilot Testing

Activities up to 5/18/10 consisted of installation and checkout, and preliminary thickening runs on digested sludge.

The runs on digested sludge were conducted on 5/18/10 through 6/2/10. See table on page 5. The piping and equipment configuration for digested sludge for the various runs was as follows:

1. Digested sludge was drawn from the centrifuge inlet line at the 120,000-gal. mixing tank (same point as for prior gravity belt thickener testing).
2. The 3-inch variable speed system feed pump and 4" magnetic flow meter from the trailer were piped into this line. The pump was not operated, due to sufficient static head available in the mixing tank.
3. A 4" variable speed dynamic mixer with a polymer inlet port was installed downstream of the flow meter.
4. A 6" air-operated pinch valve was installed downstream of the dynamic mixer. The flow rate was controlled by regulated air input to this valve.
5. A 3" bullhead tee with 2" branches was installed as the inlet to the ClearFloater™ flotation tank. Froth was directed into the branch of the tee, opposite to the flow direction of sludge.
6. Four-inch diameter hose was run to the bullhead tee on the ClearFloater™ flotation tank.
7. The underflow launder on ClearFloater™ was piped to the plant drain line leading to the sump and pumped back to the SRWTP.
8. The float box on ClearFloater™ was modified by Synagro to attach to a 6" pipe and hose connection to the 6" Vogelsang pump.
9. The discharge of the 6" Vogelsang pump was piped to the 4" drain on the mixing tank. A 2" branch at the discharge had a hose discharging to a thickened sludge holding tank. For runs before 5/27/10 this holding tank was the trailer's conditioning tank. As of 5/27/10, the GBT feed tank was used instead because it contained a properly designed turbine agitator.
10. The drain of the thickened sludge holding tank was connected to the centrifuge inlet at the progressing cavity pump suction.
11. For runs prior to 5/25/10, one of the plant's Vogelsang centrifuge polymer feed pumps was used to meter polymer at 0.32% into the dynamic mixer in the sludge feed line to the trailer. A timed fill was performed on 5/18/10 to calibrate this pump relative to the plant's VFD and flow meter.
12. For the runs on 5/27/10 and 6/3/10, the Polymixer was used to meter made-down emulsion polymer into the dynamic mixer in the sludge feed line to the trailer.
13. For the runs on 6/2/10, the 264 gph polymer metering pump was used to meter made-down dry polymer to the dynamic mixer in the sludge feed line to the trailer.
14. For the run on 5/24/10, the 264 gph polymer metering pump was used to meter made-down dry polymer to a 6" dynamic mixer in the thickened sludge feed line to the centrifuge.
15. For the run on 5/27/10, emulsion polymer was metered directly into the centrifuge's polymer system.

Return Activated Sludge (RAS), equivalent in composition to Waste Activated Sludge (WAS) was collected from one of the SRWTP RAS channels on 5/25/10 and 6/3/10 and dumped into the 20,000-gallon holding tank. See table on page 5. The configuration list for WAS was generally similar to that for digested sludge, as follows:

1. WAS feed from the holding tank drain was piped to the suction of the 3" variable speed system feed pump. This pump was run to produce the desired flow rate. The pinch valve remained partially closed and was not adjusted.
2. Items 3 and 5 through 8 in the above digested sludge configuration list remained the same.
3. For the 5/25/10 run, the 2" branch discharge of the 6" Vogelsang pump was connected with a hose to the trailer's conditioning tank. For the 6/3/10 run, this branch discharge was connected to the 1900-gallon insulated polyethylene tank.
4. For both runs, polymer feed to WAS influent to trailer was configured as in Item 12 of the above list.
5. For the run on 5/25/10, polymer feed to thickened WAS from the conditioning tank was configured as in Item 14 of the above list.
6. For the run on 6/4/10, polymer feed to thickened WAS from the 1900-gallon insulated polyethylene tank was configured as in Item 15 of the above list.

The 6/4/10 centrifuge run was made pursuant to a suggestion to heat treat thickened WAS in an attempt to break down the cell walls and thereby improve dewaterability. Synagro fabricated a shell and tube heat exchanger using 1-1/4" EMT and a 15-foot length of PVC pipe, and connected the plate condenser discharge (158 °F water temperature) to the shell side. The thickened WAS in the 1,900-gallon insulated tank (former caustic tank) produced on 6/3/10 was circulated through the tube side, with compressed air added to the circulating sludge. The thickened WAS temperature rose from 70 °F to 112 °F in approximately 5 hr., and a temperature of 118 °F was maintained until the end of the centrifuge run. The thickened WAS was held at temperature for 3.5 to 5 hr. prior to centrifuging. Dewatered solids measuring 25%, equivalent to digested sludge, were produced, with polymer consumption comparable to that for digested sludge. Synagro made qualitative observations of the mechanical consistency of the dewatered WAS in comparison with dewatered digested sludge, finding them equally suitable for drying in the drum dryer.

Heron SAF™ Thickening and Centrisys Centrifuge Dewatering Data

Date	5/18/10	5/18/10	5/20/10	5/20/10	5/24/10	5/25/10	5/27/10	6/2/10	6/3/10	6/3/10	6/4/10
Material	D. S.	D. S.	D. S.	D. S.	D. S.	WAS	D. S.	D. S.	WAS	WAS	WAS
%TS to SAF	1.6	1.6	ND	ND	1.55	0.449 A&L: 0.584	ND	1.33	0.4	0.4	N/A
Q, gpm	60	100	ND	ND	60	ND	ND	50	175	80	N/A
HLR, gpm/ft^2	3.4	5.7	ND	ND	3.4	ND	ND	2.9	10	4.6	N/A
SLR, #/hr/ ft^2	27.5	45.7	ND	ND	26.6	ND	ND	22.2	20	9.1	N/A
A:S, %	0.44	0.4	ND	ND	ND	ND	ND	ND	0.57	ND	N/A
Polymer (1)	858BS	858BS	858BS	858BS	Ciba	K148L	K148L	7557	K148L	K148L	N/A
dosage, #/dry T	15.2	13.7	13.5	16	13.8	20 (+/-)	18	14.5	24.2	24	N/A
Thickened %TS	5.27	(video)	3.72 (fast skim)	5.3	3.46	ND	ND	4.19	2.28	3.07	N/A
Underflow TSS, mg/L	ND	(video)	ND	ND	ND	69	ND	ND	ND	ND	N/A
%TS to centrifuge	N/A	N/A	N/A	N/A	3.46	ND	ND	N/A	N/A	N/A	3.69 (4) (heated)
Centrifuge Q, gpm	N/A	N/A	N/A	N/A	6	ND	ND	N/A	N/A	N/A	8.5
Polymer	N/A	N/A	N/A	N/A	Ciba	Ciba	K148L	N/A	N/A	N/A	K148L
dosage, #/dry T	N/A	N/A	N/A	N/A	37	17 (?)	14	N/A	N/A	N/A	17.8
Dewatered %TS	N/A	N/A	N/A	N/A	24.6	18.5 (Synagro)	28 (video)	N/A	N/A	N/A	24.95
Centrate TSS, mg/L	N/A	N/A	N/A	N/A	ND	11,840	ND (3)	N/A	N/A	N/A	< 10

NOTES:
1. 858BS – Ashland product currently used. Ciba – Dry polymer similar to 858BS. K148L – Ashland emulsion polymer similar to 858BS. 7557 – Ciba dry polymer having 58% charge density.
2. Plant measured 18.5%. Notation "A&L" refers to A&L Labs analytical results not yet provided by Synagro.
3. Observed to be very clear.
4. Heated to greater than 115 °F for 3.5 – 5 hr. A&L result. Plant measured 2.85%.

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