Reducing dewatered sludge cake volume: a practical demonstration

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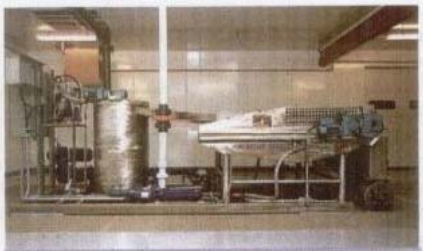
With the advent of new legislation and emphasis on sludge treatment, generally the 1st phase (excluding digestion) in the sludge treatment process will be sludge dewatering. Historically sludge drying beds were used for this, however, mechanical sludge dewatering and specifically sludge dewatering using a belt press is now regarded as the norm for sludge volume reduction.

Within the US there are many different manufacturers of sludge dewatering belt presses, from the single belt to large double belt presses, and triple belt press system which incorporates a belt thickener prior to the dewatering belt press. The large double and triple belt presses tend to be outside the financial range of the small to medium sized waste water treatment plant.



OR-TEC HP 1500 Belt Press System at Oak Harbor WWTP

The actual reduction in volume from the single belt press to the double/triple belt press is not great (see Table 1)

TABLE 1	SINGLE BELT PRESS	DOUBLE BELT PRESS
Sludge Production *	500 lbs d.s./day	500 lbs d.s./day
Final Cake Concentration	16.5%	18%
Final Cake Production	3,030 lbs/day	2,777 lbs/day
Weekly Cake Production	21,210 lbs	19,444 lbs

and in most cases does not justify high capital cost of the double/treble belt systems for the small and medium size facilities.

* *Anticipated sludge production from a typical 0.5 mgd municipal W.W.T.P., based on an inlet loading of 200 mg/l of BOD.*

What direction will the industry take to change, upgrade or improve the performance of the sludge dewatering systems that will allow it to keep abreast of the regulatory requirements? In short, what is the small or medium sized WWTP to do without spending large amounts of money for processes that were originally developed for large towns or cities.

Stored Sludge at Oak Harbor WWTP

EXISTING TECHNOLOGY

While there are many options available our focus here is primarily on the small to medium sized facilities and the products available for further sludge drying following mechanical dewatering. The most commonly used methods are;

1. COMPOSTING
2. HEAT DRYING
3. ADDITIVES

1. COMPOSTING

With composting we have the most natural form of enhancing the sludge and the end product has an added value as a soil conditioner.
However with composting you will require some or all of the following:

Drying material
- (1) Wood chip
- (2) Sawdust
- (3) Leaves/grass

Mixing equipment
- (1) Large end loader
- (2) Drum mixer (possibly)

Monitoring
- (1) Ratios
- (2) Temperature

Operator

2. HEAT DRYING

Heat drying is probably the most convenient method for treatment and sludge volume reduction. The dewatered cake from the belt press is transported via a conveyor/auger and loaded into the dryer that in turn heats the sludge cake to evaporate the moisture. To achieve this goal the material will stay within the dryer for a set period, the longer in the dryer the more moisture it removes.

The capital and operational costs for heat drying are very high and in the vast majority of cases outside the range of small to medium WWTP. The equipment requirement will again include some or all of the following.

Sludge transfer equipment:
- (1) Conveyor
- (2) Auger
- (3) End loader

Drying equipment:
- (1) Drier
- (2) Energy (oil, gas, or electricity)
- (3) Heat transfer system
- (4) Holding mixing vessel

Storage
- (1) Sludge Cooling Area

Operator

3. ADDITIVES

Additives to sludge including lime, kiln dust, etc. these materials will increase solids concentration of sludge. It should be noted the sludge volume for disposal also increases with this option as the process involves adding dry material rather than drying the sludge. However with lime or kiln dust the end product will be enhanced making it easier to dispose of the final sludge cake.

There will be capital and on-going costs for operations such as this.
Capital equipment requirement:
- (1) Pug mill
- (2) Augers
- (3) Front end loader
- (4) Lime Feeder

Ongoing expenditures
- (1) Lime or Kiln dust
- (2) Operator
- (3) Health and Safety Issues

Liquid lime is available and can be used as an alternative to the above and is more convenient and less expensive from a capital point of view. It is also however expensive on a per pound basis and as it is considered a hazardous material it is expensive to transport.

Dewatered sludge at 1.01% from OR-Tec Belt Press

ALTERNATIVE METHOD OF ENHANCING THE DEWATERED CAKE FOR A SMALL TO MEDIUM SIZED W.W.T.P'S.

In 2003 in conjunction with the city of Oak Harbor, Ohio, a full scale trial was carried out at their existing sludge handling facility.

The intent during the trial was to establish a low cost yet simple method of reducing the final cake from the belt press. The trial took place over a period of 16 weeks under the direction of Mr. John Liske, plant superintendent, and his staff.

BACKGROUND INFORMATION

In 2000 Oak Harbor WWTP installed an OR-TEC HP 1500 Belt Press and converted the existing drying beds into a covered storage area. See Table 2 for the typical operating results of the belt press.

Table 2

Inlet solids concentration	2.0%
Final cake concentration	17.5%
Sludge volume reduction	88%
Capture	95%
Polymer dosage rate	8-10 lbs. per ton d.s.

In June 2003 the operators set aside a space within the covered storage area to store and mix one ton of dewatered cake. Most weeks for the next 16 weeks the sludge cake was turned using a skid loader. This operation took no more than 5 minutes of the operator's time. A control one ton of sludge was placed next to the above sample. The control sludge cake was not turned.

Samples we taken and tested onsite by Oak Harbor personnel during this period to determine the cake concentration. The following page (Table 3) is a copy of the actual log kept by personnel at the Oak Harbor WWTP

Table 3

The sludge concentration going to the belt press was 2% solids. Following dewatering with the belt press system the sludge concentration was 17.01% solids. This represents a volume reduction for disposal of 88.2%.

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Table 3 Oak Harbor 7-16-03

MIXED SLUDGE - 1@week			CONTROL - NO MIXING		
DATE	% DRY	MIXED	DATE	% DRY	TEMP
7-16-03	17.01		7-16-03	17.01	
7-19-03	17.81	✓	N/A	N/A	
7-23-03	19.28	✗	7-23-03	20.36	
7-30-03	25.34	✗	7-30-03	20.10	
8-13-03	49.70	✓	8-13-03	33.50	
8-20-03	47.36	✗	8-20-03	34.12	
8-26-03	48.12	✗	8-26-03	38.66	80°
9-3-03	36.74	No	9-3-03	27.37	74°
9-18-03	38.88	Yes	9-18-03	26.39	64°
9-24-03	56.50	Yes	9-24-03	40.19	62°
10-1-03	40.75	Y	10-1-03	29.65	60°
10-22-03	65.38	Y	10-22-03	40.30	50°
10-29-03	52.20	N	10-29-03	39.12	44°
11-5-03	56.71	Y	11-5-03	40.76	58°

Table 4 below is a summary of Table 3 showing the additional volume reduction achieved during sludge storage.

TABLE 4	Sludge Solids Prior to Storage	Sludge Solids Following Storage	Per Cent Volume Reduction During Storage Phase
Mixed Cake	17.01%	56.71%	70%
Control Non-Mixed	17.01%	40.76%	58.2%

Taking the final cake concentration on the completion of the trial we can the see a total volume reduction of 96.47% in sludge for disposal from the inlet solids concentration (2%) to stored sludge (56.71%).

THE REAL WORLD

To put this into perspective we can view these numbers as they would relate to a 0.5 mgd plant. Looking at **Table 1** we can see a 0.5 mgd plant will produce 21,210 lbs per week of sludge cake for disposal following dewatering to 16% solids. By going to the next stage and storing and turning the sludge for a period of time we bring the solids up to the 56% range and get a further 70% reduction in volume. The 21,210 lbs is now reduced to 6,197 lbs cake for disposal. In other words every week, plant personnel have to dispose or haul 6,197 lbs of sludge cake instead on 21,210 lbs sludge cake per week.

Sludge at 56.71% from the mixed pile at the end of the test. Sludge cake is dry and granular consistency.

Sludge from the unmixed pile at the end of the test Cake is lumpy and solids concentration varies.

GENERAL OBSERVATIONS

This test was conducted during the summer and temperatures are recorded on Table 3. The first number of weeks when the temperature was not recorded averaged 70F. to 80 F.

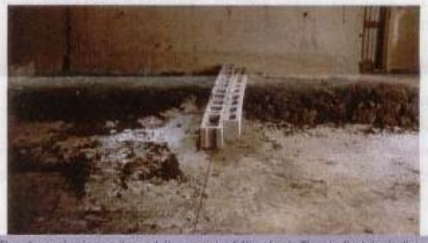
The sludge storage area itself is a large converted drying bed area with a sloped concrete floor to a central drain. The entire sludge storage is enclosed in steel, roofed building with concrete hip walls. During the day plant operators normally open the large double doors on one side of the building and turn on several large extraction fans on the far wall.

The sludge being produced by Oak Harbor normally dewaters to 17% solids on the belt press. At 17% the sludge will pile to about 36". The one ton piles used for the test were approximately 24"in height. During the test the control sludge pile dewatered to approximately 10% less than the mixed sludge pile. With larger quantities of non-mixed sludge piled to heights of 36" a crust tends to form on the top of the sludge. This crust acts as a barrier to evaporation and therefore dewatering. From this we conclude that with larger, higher piles of sludge the benefits of mixing the sludge become more apparent and a drier product results.

On inspection the physical characteristics of the mixed sludge and control sludge were very different. The mixed sludge consisted of homogeneous popcorn sized particles and had the same solids concentration throughout. The non-mixed control sludge was far less consistent. It consisted of small dry particles and larger wetter clumps. It was drier towards the top of the pile and wetter toward the bottom.

The site for this test Oak Harbor WWTP used existing drying beds for their sludge storage area. As a large percent of the waste water treatment plants putting in sludge dewatering belt presses are doing so to replace drying beds, utilizing these same beds is ideal for this type of application. A sloped concrete floor toward a trench drain is all that is required. A skid loader was used to turn the sludge during these tests.

If a large space is available windrowing is good option as it allows the sludge to be turned easily.



The two sludge piles at the end of the test. The left side is the mixed pile. On the right is the non-mixed, control pile.

CONCLUSION

Simple storage and mixing gives a large additional volume reduction to mechanically dewatered solids. For the small to medium wastewater treatment plant with limited personnel and capital to invest in more expensive sludge drying systems, storing and turning dewatered sludge provides a low cost and low labor method of reducing sludge cake volume for disposal. For more information contact Jim O'Leary at 440-232-4224 or **circle number 249 on card**