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Biosolids Technology Fact Sheet
Belt Filter Press

DESCRIPTION

Belt filter presses are used to remove water from liquid wastewater residuals and produce a non-liquid material referred to as "cake". Dewatered residuals, or cake, vary in consistency from that of custard to moist soil. Dewatering serves the following purposes:

- Reducing the volume, thus reducing storage and transportation costs.
- Eliminating free liquids before landfill disposal.
- Reducing fuel requirements if residuals are to be incinerated or dried.
- Producing a material which will have sufficient void space and volatile solids for composting when blended with a bulking agent.
- Avoiding the potential of biosolids pooling and runoff associated with liquid land application.
- Optimizing subsequent processes such as thermal drying.

A belt filter dewaters by applying pressure to the biosolids to squeeze out the water. Biosolids sandwiched between two tensioned porous belts are passed over and under rollers of various diameters. Increased pressure is created as the belt passes over rollers which decrease in diameter. Many designs of belt filtration processes are available, but all incorporate the following basic features: polymer conditioning zone, gravity drainage zones, low pressure squeezing zone, and high pressure squeezing zones. Advanced designs provide a large filtration area, additional rollers, and variable belt speeds that can increase cake solids by five percent.

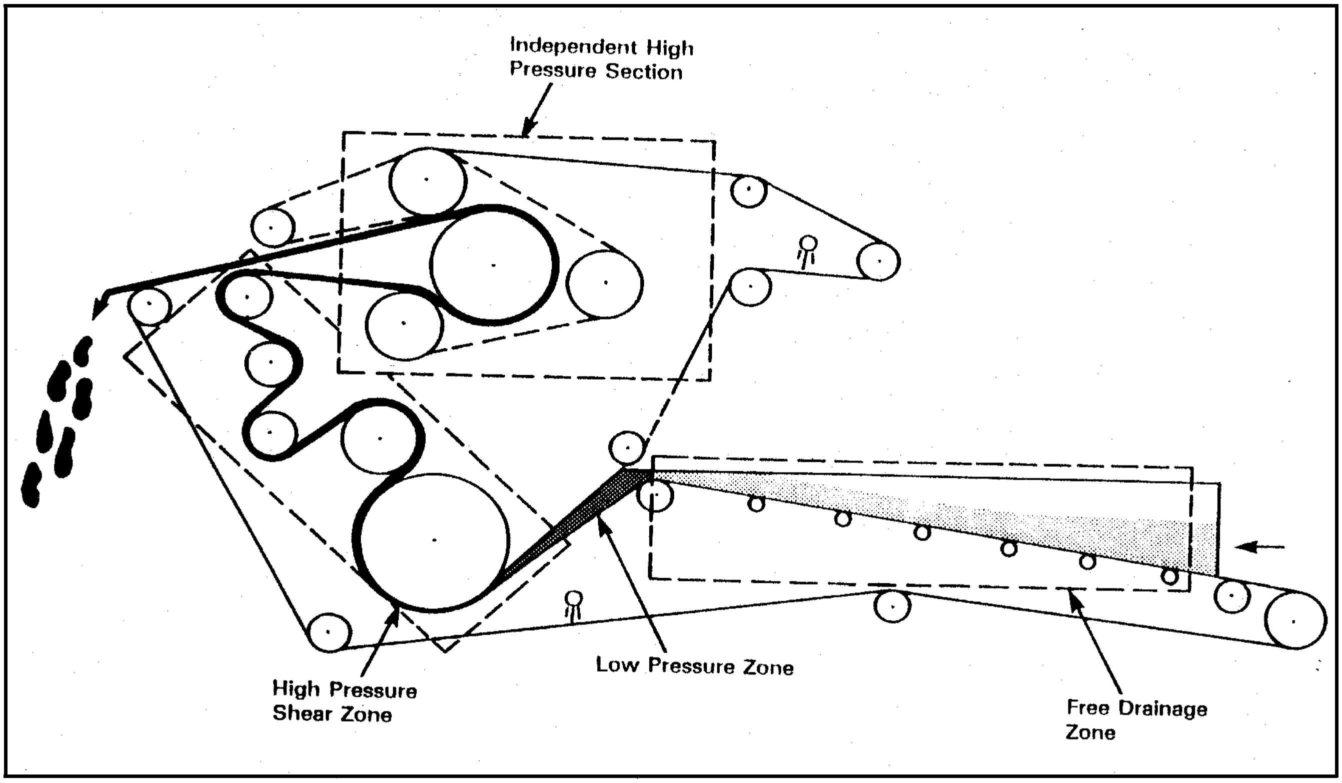
The general mechanical components of a belt filter press include dewatering belts, rollers and bearings, belt tracking and tensioning system, controls and drives, and a belt washing system. Figure 1 depicts a typical belt filter press.

APPLICABILITY

Belt filter presses can be used to dewater most biosolids generated at municipal wastewater treatment plants and are a common type of mechanical dewatering equipment. Using mechanical equipment to dewater solids may not be the most cost effective alternative for wastewater treatment plants operating at less than about 4 mgd. The selection of dewatering equipment should be based on the results of a site specific biosolids management plan which identifies both processing and end use alternatives and estimates costs. It may be less expensive to haul liquid to an application site or pay a processing facility to dewater and process or landfill the dewatered cake. Smaller facilities should also evaluate non-mechanical dewatering methods, such as drying beds or reed beds.

ADVANTAGES AND DISADVANTAGES

Advantages and disadvantages of belt filter presses for dewatering wastewater solids are summarized below:



Source: U.S. EPA, 1987.

FIGURE 1 SCHEMATIC OF A BELT FILTER PRESS

Advantages

- Staffing requirements are low, especially if the equipment is large enough to process the solids in one shift (USEPA, 1987).

- Maintenance is relatively simple and can usually be completed by a wastewater treatment plant maintenance crew. Replacing the belt is the major maintenance cost.

- Belt presses can be started and shut down quickly compared to centrifuges, which require up to an hour to build up speed (Henderson and Schultz, 1999).

- There is less noise associated with belt presses compared to centrifuges (Henderson and Schultz, 1999).

Disadvantages

- Odors may be a problem, but can be controlled with good ventilation systems and chemicals, such as potassium permanganate, to neutralize odor-causing compounds (Rudolf, 1992). Some manufacturers offer fully enclosed equipment to minimize odors and reduce vapors in the operating room air (Bain et al., 1999).

- Belt presses require more operator attention if the feed solids vary in their solids concentration or organic matter. This should not be a problem if the belt presses are fed from well-mixed digesters (Henderson and Schultz, 1999).

- Wastewater solids with higher concentrations of oil and grease can result in blinding the belt filter and lower solids content cake.

- Wastewater solids must be screened and/or ground to minimize the risk of sharp objects damaging the belt.

- Belt washing at the end of each shift, or more frequently, can be time consuming and require large amounts of water

(Henderson and Schultz, 1999). An automatic belt washing system and the use of effluent can minimize these costs.

DESIGN CRITERIA

Belt presses are sized on the basis of weight or volume of solids to be dewatered rather than the wastewater flow to the plant. To determine how many presses are needed, the wastewater treatment plant must:

- Determine the amount of primary solids that will flow through the plant per day.
- Determine the amount of waste-activated or trickling filter solids produced per day.
- Determine the volume of thickened solids to be dewatered per day.
- Estimate the range of dry solids concentration in the feed.
- Estimate future increases in solids production.
- Anticipate changes in sewer discharges or operation that could change solids quality or organic matter content.

An effective biosolids management plan will include the above information. It is important to design for excess capacity so that the anticipated amount of incoming solids can be easily dewatered during operating hours. Allowing for excess capacity also ensures that the plant will not experience a build-up of solids if a unit is out of service. If only one unit is required, the plant should have an alternate program to remove solids in liquid form.

The polymer conditioning zone can be a small tank, approximately 265 to 379 liters (70 to 100 gallons) located 0.6 to 1.8 meters (2 to 6 feet) from the press, a rotating drum attached to the top of the press, or an in-line injector. The press manufacturer usually supplies this zone along with the belt filter press (USEPA, 1986).

The gravity drainage zone is a flat or slightly inclined belt unique to each model. Solids are dewatered by the gravity drainage of the free water. A 5 to 10 percent increase in solids concentration from the original biosolids should occur in this zone (USEPA, 1987). The free water drainage is a function of wastewater solids type, quality, conditioning, screen mesh, and design of the drainage zone.

The low-pressure zone is the area where the upper and lower belts come together with the wastewater solids in between. This is sometimes called the "wedge zone," because the feed solids are sandwiched between the upper and lower belts. The low-pressure zone prepares the biosolids by forming a firm cake which can withstand the forces of the high pressure zone.

In the high-pressure zone, forces are exerted on the solids by the movement of the upper and lower belts as they move over and under a series of rollers of decreasing diameter. Some belt filter press models separate from the rest of the unit to increase pressure on the biosolids. This produces a drier cake, an important factor for plants that incinerate the final product or face high end use or disposal costs. A biosolids management plan should evaluate the advantages and disadvantages of a high performance belt filter press.

An additional design feature is a self-enclosed facility to reduce odors and protect worker health (Bain et al., 1999). Workers in the belt press areas are exposed to aerosols from wash spray nozzles and pathogens and hazardous gasses such as hydrogen sulfide. Enclosing the press reduces visibility to the operators and produces a corrosive environment for the rollers and bearings, but automating the system can alleviate these problems.

The automation of belt presses is the subject of a Water Environment Research Foundation project. Benefits of automation include optimization of non-linear variables which was rarely possible with manual or semi-automated operation, and the ability to produce dewatered cake at a constant rate. Automation generally increases capital costs by 10 percent. Manufacturers claim that this extra expense is worthwhile because it lowers labor costs, reduces polymer use, and maximizes the solids content of the cake, reducing disposal and end use costs (Gillette et al., 2000).

The choice of dewatering technique and chemical polymer or salts impacts dewaterability as well as the potential for odor during further processing or recycling to land.

Ancillary equipment for efficient operation of a belt press includes:

- Polymer.
- Mixing, aging, feed, liquid feed day tank.
- Liquid residuals feed pump.
- Odor control and ventilation.
- Conveyor and/or pump to move dewatered cake.
- An enclosed area to load trucks or containers.

PERFORMANCE

Manufacturers should be consulted for design and performance data early in the planning stage. Data should be confirmed with other operating installations and/or thrash pilot testing. Evaluation of equipment should consider capital and operating costs, including polymer, electricity, wash water, solids capture, and ventilation and odor control during dewatering and further processing or recycling. The operator can ensure system integration by requiring that the self-enclosed belt press, ventilation, and polymer system is supplied by a single provider. Since solids characteristics and quantity vary from plant to plant, it is important to evaluate different weaves, permeability, and solids retention abilities of dewatering belts to ensure optimum performance. Surveys of similar plants or testing of wastewater solids can be helpful in the decision-making process.

Table 1 displays the range of performance of a high pressure belt press on various types of wastewater solids.

Odor Control

Odor complaints at wastewater treatment plants and biosolids end use sites can interfere with implementation of the most cost effective biosolids management options. Odor control measures should be included when designing dewatering facilities. Odor control is addressed in more detail in another fact sheet, but briefly, the methods include:

TABLE 1 TYPICAL DATA FOR VARIOUS TYPES OF SLUDGES DEWATERED ON BELT FILTER PRESSES

Type of Wastewater Sludge	Total Feed Solids (percent)	Polymer (g/kg)	Total Cake Solids (percent)
Raw Primary	3 to 10	1 to 5	28 to 44
Raw WAS	0.5 to 4	1 to 10	20 to 35
Raw Primary + WAS	3 to 6	1 to 10	20 to 35
Anaerobically Digested Primary	3 to 10	1 to 5	25 to 36
Anaerobically Digested WAS	3 to 4	2 to 10	12 to 22
Anaerobically Digested Primary + WAS	3 to 9	2 to 8	18 to 44
Aerobically Digested Primary + WAS	1 to 3	2 to 8	12 to 20
Oxygen Activated WAS	1 to 3	4 to 10	15 to 23
Thermally Conditioned Primary + WAS	4 to 8	0	25 to 50

Source: U.S. EPA, 1987.

- Using a self enclosed belt press.

- Adding potassium permanganate or other oxidizing agent to minimize odors in the solids.

- Minimizing liquid storage prior to belt pressing to less than 24 hours. The longer the solids are stored, the lower the pH, the higher the liquid ammonia concentration, and the higher the organic sulfide emissions (Hentz et al., 2000).

- Conducting bench-scale and full-scale testing of liquid sludge to determine if combined storage of primary and waste activated sludges accelerates the deterioration of biosolids (Hentz et al., 2000).

- Specifying polymers that are stable at elevated temperatures and pH. This is especially important at facilities using lime stabilization or high temperature processing such as heat drying, thermophyllic digestion, or composting.

Self-Enclosed Belt Presses

The main purpose of a self-enclosed system is to minimize the amount of foul air needing treatment in an odor control system. An induced draft fan provides a slight negative pressure (typically 100 cubic feet per meter per meter of belt width.) The system design should:

C Minimize gaps in the enclosure.

C Minimize enclosure volume.

C Locate mechanical and electrical components requiring maintenance outside the enclosed area for easy access and reduced maintenance.

C Include automation to optimize performance of the belt press.

C Use stainless steel materials.

C Provide multiple access hatches to allow operator viewing and clean up.

C Provide for easy removal of the belt for replacement (Bain et al., 1999).

Chemical Addition

Solids must be conditioned with polymer to ensure optimum performance. Polymer feed points should be designed at several locations to ensure flexibility and optimum performance. The solids/polymer mixture should be subject to gentle mixing as turbulent conditions can sheer the floc, minimizing polymer effectiveness. Polymer dilution and aging systems should be large enough to optimize polymer usage.

Potassium permanganate or other oxidizing agents are often added to solids prior to dewatering. These have been shown to reduce odors caused by sulfides, reduce the amount of polymer needed, and increase cake solids content (Rudolf, 1992). Figure 2 shows dewatered solids from a belt filter press after processing.

Source: Dr. Peter Wright, Cornell University, 1996.

FIGURE 2 DEWATERED SOLIDS CAKE DROPPING FROM BELT FILTER PRESS AFTER PROCESSING

OPERATION AND MAINTENANCE

It is important to monitor operating parameters to achieve optimum performance and ensure that solids are properly conditioned and that good gravity drainage occurs. The manufacturer should provide operation and maintenance training after installation as well as ongoing training to maintain skills.

Dewatering belts should be designed for easy replacement with minimum downtime. Belt washing should occur daily after the cake is removed.

Replacement of filter belts is a common maintenance requirement. Belt life averages about 2,700 running hours, with a range of 400 to 12,000 hours.

A belt press operator is responsible for polymer mixing, dosing and monitoring usage, and observing the feed and cake several times per day, making adjustments as necessary. Rollers and bearings require frequent lubrication.

It is important for the operator to keep records of all press performance parameters, including the volume of biosolids fed to the press, polymer dosage, and potassium permanganate or other chemical usage. A sample of the biosolids to the press, cake discharge, and filtrate should be taken at least once per shift and analyzed for total solids. At the end of each shift, the belt should be cleaned with high-pressure wash water. Labor is relative to plant size. A plant with a single belt press needs four to eight staff hours per day (including lab testing), whereas six to eight presses can be operated with eight to ten staff hours per day. Large plants use less operating effort per belt press. Highly automated systems reduce labor requirements, but require an instrumentation specialist to maintain the system.

COSTS

Capital costs for belt filter presses vary with the size of the equipment. Vendor estimates vary from $47,500 (0.5 meter belt, approximate capacity of 500 dry pounds per hour) to $115,000 (1.5 meter belt with approximate capacity of 1,625 dry pounds per hour). These estimates are based on a feed material which is 5 percent solids. These prices do not include the cost of installation, shipping, or ancillary equipment, such as flow control and centrate management.

Overall operation and maintenance costs range from $80 per dry ton of solids (DTS) to $200 per DTS. Typical polymer conditioning costs for belt filter press dewatering range from $2.65 per million gallons to $91.15 per million gallons, and average $24.38 per million gallons. Permanganate adds about $1 per million gallons to the cost of dewatering the biosolids. These costs vary widely, depending on the source of the residuals. The polymer costs for raw primary may cost $12 per DTS, but may be as high as $80 per DTS for residuals that are difficult to dewater.

REFERENCES

Other Related Fact Sheets

Odor Management in Biosolids Management
EPA 832-F-00-067
September 2000

Alkaline Stabilization of Biosolids
EPA 832-F-00-052
September 2000

Land Application of Biosolids
EPA 832-F-00-064
September 2000

In-Vessel Composting
EPA 832-F-00-061
September 2000

Other EPA Fact Sheets can be found at the following web address:
http://www.epa.gov/owmitnet/mtbfact.htm

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