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Biosolids Technology Fact Sheet

Recessed-Plate Filter Press

DESCRIPTION

Recessed-plate filter presses are used to remove water from liquid wastewater residuals and produce a non-liquid material referred to as “cake”. Dewatered cake varies in consistency from that of custard (12 to15 percent solids) to moist soil (20 to 40 percent solids) and is used for the following purposes:

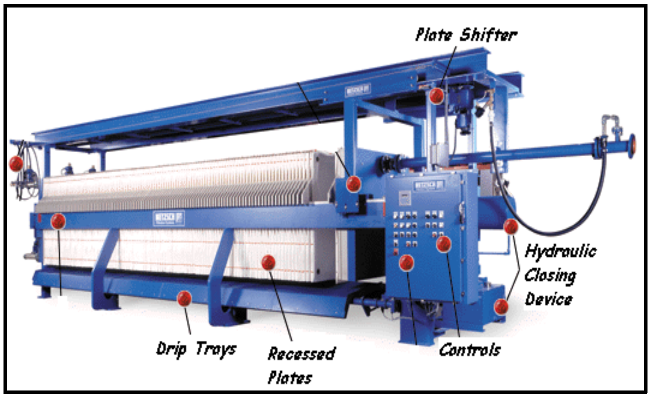
- To reduce volume, saving money on storage and transportation.
- To eliminate free liquids prior to landfill disposal.
- To reduce fuel requirements if the residuals are to be incinerated or further dried.
- To produce a material with sufficient void space and volatile solids for composting when blended with a bulking agent.
- To reduce pooling or runoff, which can be a problem when liquid biosolids are land applied.
- To optimize alkaline stabilization processes.

Recessed-plate filter presses are among the oldest types of dewatering devices and can produce the highest cake solids concentration of any mechanical dewatering equipment (Kemp, 1997). They are more commonly used in industrial applications than in municipal wastewater facilities.

The recessed-plate filters are polypropylene squares which may be two to four feet across, with a concave depression and a hole in the middle. Two plates are joined to create a chamber to pressurize solids and squeeze out liquid through a filter cloth lining the chamber. Several plates (ranging from 12 to 80, depending on the capacity required) are suspended from a frame face to face. A series of chambers is formed when the press is closed. Conditioned solids are pumped into the center hole to fill each chamber. As pressure increases, either by adding more conditioned solids (fixed volume press) or by expanding a membrane (variable volume press), solids are retained on the filter cloth while liquid passes through and is drained away from the machine. Free water is released and passes through the filter cloth during the filling phase. Pressure builds as the chamber fills with solids beginning the consolidation process (Kemp, 1997). The feed pump must be able to develop the required filtration pressure (100psi to 225psi). To perform effectively, the terminal pressure is reached during consolidation and filtrate flow declines. Cake is formed until a set-point of low filtrate flow is reached to indicate the end of the cycle.

Filter press capacity is determined by the number and size of plates and chambers in the press (Kemp, 1997). The plates are supported on a structural frame with a shifting mechanism to separate them one at a time. Large presses have automatic plate-shifting systems that press together the plates and filter cloths with a hydraulic ram, sealing the edges of the cloths on the plates and resisting the filtration pressure developed by the filter feed pump during the filtration process (Kemp, 1997). Figure 1 shows a typical recessed plate filter press.

Filter presses are normally mounted on the floor above a conveying system or the containers that receive the solids. The cake drops as each chamber is opened (Kemp, 1997).



Source: Netzsch, Inc. 1999.

FIGURE 1 RECESSED-PLATE FILTER PRESS

Biosolids managers should consider two types of presses. The conventional press has a fixed volume which removes moisture by adding more solids. The diaphragm press is a variable volume press in which sturdy hollow rubber diaphragm or membrane is positioned behind each filter cloth. Water is pumped to the interior of the diaphragms when the maximum feed pump pressure is reached, expanding the diaphragm reducing the volume of cake solids.

The diaphragm press also uses a feed pump to fill the chambers and develop pressures of up to 690 kPA (100 psi) (WEF, 1992). If the biosolids are properly conditioned, the initial filling period will remove considerable amounts of water or compress air at substantially zero headloss across the medium. The diaphragm filter press operates like a recessed plate press, at pressures between 690-1,040 kPA (100-225psi) (USEPA, 1987). However, higher pressure is achieved by expanding the diaphragms, reducing the volume of the chamber by squeezing out more water.

Diaphragm filter presses often result in a cake with a higher solids content. Bench testing should be performed on a representative sample of each wastewater treatment plant's solids to determine whether a membrane filter offers advantages over a conventional, fixed volume filter press. An economic analysis should be also conducted to determine whether the additional capital cost of a diaphragm filter press will result in long-term cost savings.

APPLICABILITY

Recessed-plate filter presses can be used to dewater most biosolids generated at municipal wastewater treatment plants. Like all dewatering equipment, these filter presses require a capital investment and labor to operate and 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 that identifies processing and end use alternatives and estimates costs. It may be less expensive to haul liquid and 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.

Wastewater plants faced with high end use or disposal costs will benefit from the ability of a recessed-plate filter press to produce the driest cake possible.

Plants that want to produce a lime stabilized product for agricultural use can use a recessed-plate filter press with lime as a conditioner. The end product will meet the 40 CFR Part 503, *Standards for Use and Disposal of Sewage Sludge* with respect to vector attraction reduction and Class A or B pathogen reduction. The metals concentration in the final product will be lower and in a less mobile form due to the high pH.

If the wastewater treatment plant wants to process the cake further, there may be economic advantages to producing the driest cake possible. Incineration or heat drying requires less fuel and may operate at a higher capacity because there is less water to evaporate while alkaline stabilization technologies require less additive, saving on the cost of the additive, storage requirements, and transportation of the final product.

ADVANTAGES AND DISADVANTAGES

Advantages

Recessed-plate filter presses offer several advantages compared to other mechanical dewatering methods, as follows:

- High cake solids concentration with associated low biosolids storage, hauling, and disposal costs (WEF, 1992).
- Little or no operator attention during dewatering phase of cycle (one to three hours) (WEF, 1992).
- Cake solids concentration is relatively independent of feed solids concentration (WEF, 1992).
- Use of lime as a conditioner stabilizes and disinfects the final product.

The advantages of a diaphragm filter press over conventional recessed-plate filter presses include the following:

- Usually produces a drier cake.
- Substantially greater uniformity of solids concentration in the cake.
- Easier to dose polymers as an alternative to ferric salts and lime conditioning techniques.
- The use of high pressure without having to introduce more liquids reduces the tendency to squeeze biosolids into the filter cloths because substantial quantities of water are eliminated before starting the pressing operation.
- Removes water uniformly because the pumping cycle is only the first part of the overall cycle.
- The cycle time for a selected cake solids concentration is usually lower (USEPA, 1987).
- Higher cake solids content improves release of the cake from the filter cloths.
- Wastewater solids only need to be pumped into the diaphragm filter press at pressures up to 865 kPA (100 psi) reducing maintenance costs (USEPA, 1987).

Disadvantages

There are also several disadvantages to using recessed-plate filter presses compared with other mechanical dewatering methods, as follows:

- Batch operation produces more heterogeneous influent (WEF, 1992).
- Process is mechanically complex.
- Capital costs are relatively high (WEF, 1992).
- Requires special support structure (WEF, 1992).
- Requires relatively large area (WEF, 1992).
- Filter cloth preparation, cleaning, and cake removal may be operator intensive (WEF, 1992).
- Cannot be totally enclosed, leaving operators exposed to odors, gaseous and vaporous sulfur compounds, and ammonia during the cake release phase.
- When lime and ferric chloride are used in conditioning, then account for a significant portion (15 to 40 percent) of the cake solids offsetting the weight reduction of high water removal efficiency.
- May require polymers for optimum performance.

DESIGN CRITERIA

Recessed-plate filter presses are sized based on the volume of solids to be dewatered. To determine the number and size of presses for a project, the following information must be determined:

- Amount of primary solids that will be flowing through the plant per day.
- Amount of waste activated solids or trickling filter solids produced per day.
- Amount of tertiary solids produced per day.
- Volume of thickened solids to be dewatered per day.
- Seasonal variation in solids production.
- Range of solids concentration in the feed solids.
- Future increases in biosolids.
- Changes in solids quality or quantity from industrial sewer users or in-plant process changes.

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

Pilot testing by the vendor offers the best way to obtain data on the important design aspects (USEPA, 1987).

Pressure is determined by filter feed-pump output (Kemp, 1997). Presses are usually designed to operate at 689.5 kPa (100 psi) or 1551 kPa (225 psi) terminal pressure. Progressive-cavity and piston-membrane pumps have been used as filter-feed pumps in these systems. A progressive-cavity pump must have variable-speed and high turndown-ratio capabilities to meet low flow requirements at the end of the cycle (Kemp, 1997). A piston-membrane pump automatically compensates for increasing pressure by bypassing hydraulic fluid and reducing the pump's stroke volume.

Recessed-plate filter press installations are mechanically complex (Kemp, 1997). System components may include conditioning tanks, mixers, multiple chemical-feed systems, feed pumps and a filtrate removal system. Ferric chloride requires corrosion-resistant facilities and extreme caution in handling. The press has a hydraulic power-pack system and other mechanical accessories for plate shifting and washing, as well as drip trays (Kemp 1997). System components are generally reliable, but require routine inspection and lubrication.

Most buildings must be custom designed to accommodate a plate and frame filter press. The cake is released to fall into a bin below the floor of the press and must be moved to a truck or roll-off container.

Because recessed-plate filter presses operate in a batch mode, the system may require a liquid storage tank. The operator may want to remove solids from a digester or settling tank in small quantities every 15 minutes rather than in large quantities every several hours.

A wide variety of filter cloth material is available. The manufacturer should test to determine the best cloth for each facility. Selecting the correct filter cloth will improve release of cake, minimize cleaning requirements, and maximize service life.

PERFORMANCE

Recessed-plate filter presses result in the highest cake solids content and the highest rate of solids capture compared to belt presses and centrifuges (Kemp, 1997).

Recessed-plate filter presses provide a good alternative for processing solids with poor dewatering characteristics (WEF, 1992). Pressure filtration allows many types of solids to be dewatered to a solids content above 30 percent. Table 1 shows the performance of various types of domestic wastewater solids, with 10 to 30 percent lime and 5 to 7.5 percent ferric chloride on a dry weight basis added for conditioning.

TABLE 1 PERFORMANCE FOR VARIOUS TYPES OF DOMESTIC WASTEWATER SOLIDS

Type of Wastewater Solids	Feed TS (%)	Typical Cycle Time (hours)	Cake TS (%)
Primary + WAS	3 - 8	2 - 2.5	45 - 50
Primary + WAS + Trickling Filter	6 - 8	1.5 - 3	35 - 50
Primary + WAS + $FeCl_3$	5 - 8	3 - 4	40 - 45
Primary + WAS + $FeCl_3$ - digested	6 - 8	3	40
Tertiary with lime	8	1.5	55
Tertiary with aluminum	4 - 6	6	36

Source: WEF,1992 and conversations with manufacturers and operators.

Septic sludges are difficult to dewater. Adding potassium permanganate to the thickener or prior to pressing will reduce odors and improve dewatering.

Tests with polymer instead of lime and ferric chloride resulted in a cake of 45 percent total solids (TS) for primary solids and a cake of 35 percent TS for a mixture of primary solids and waste activated sludge (WAS).

OPERATION AND MAINTENANCE

Unless the inorganic content of the feed solids is high, conditioning chemicals are required for successful filter press dewatering (Kemp 1997). In the past, filter presses relied on lime and ferric chloride for conditioning. While these chemicals typically produced a dewatered cake with more than 40 percent solids content, they increased the mass to be stored, transported, used or disposed. Lime is also associated with ammonia releases which must be considered in overall facility design, including ventilation and odor control requirements.

Operating a filter press manually in a small plant is simple (Kemp, 1997). Batches of solids are preconditioned and fed to the press. Monitoring is not required during the filtration cycle. If cake release is good, it will drop cleanly from the cloth when the plates are shifted. In larger units, plate shifting is automatic; smaller units use a power-assisted plate shifter.

Facilities with multiple presses need a fully automatic system for efficient operation (Kemp, 1997). Maintain proper chemical dosages, open and close the press, and blow out the core at the end of the cycle. Even in an automated system, the plate-shifting step must be initiated manually so the facility can prepare to receive the cake drop.

Filter cloths require periodic washing (Kemp, 1997). Larger presses have automatic washers that require a high-pressure pumping system to supply spray water. In some installations, the press can be filled with an acid cleaning solution to remove scale deposits when lime is used for conditioning. Acid washing may reduce filter cloth life and replacing filter cloths is labor-intensive. Filter cloth life depends on the material, solids type, conditioning, and washing frequency.

The use of polymer in variable speed plate and frame presses requires automation to control the dose as polymer dose is related to the volume of filtrate exiting the press. Polymer conditioning has been used with some success in recessed-plate filter press dewatering (Kemp, 1997). High cake solids are possible, but cycle times are long and the cake often sticks to the cloth, requiring assistance for its removal. Residual solids often remain on the cloth, reducing solids capture and requiring more frequent cleaning. Polymer conditioning is most successful in diaphragm systems because dosing is not as complicated. Filtration cycle times with lime and ferric chloride conditioning range between one and three hours. With polymer conditioning, filtration cycles may exceed three hours and tend to dewater the core, making core blowout ineffective. An advantage of polymer conditioning is that it produces cake with fewer inert solids, enabling more solids to be processed per cycle than with lime and ferric chloride. The cake contains more volatile solids than when processed with inorganic conditioning and therefore can be disposed of by incineration or other type of thermal processing (Kemp, 1997).

The degree of operator activity associated with filter presses is similar to that of belt presses. Although the press operates unattended during filtration, the system uses a batch process that requires regular operator attention to fill and unload the press (Kemp, 1997). When filtration is complete, compressed air should be used to blow out the core since it is filled with partially dewatered cake at the end of the filtration cycle.

It is not possible to take grab samples of solids during the operation with a diaphragm filter press, requiring the creation of a directed sampling program to obtain a full description of machine operation (USEPA, 1987).

Record-keeping is essential for all operations that require conditioning (USEPA, 1987). The operator must keep a log of the lime and ferric or polymer dosage required to reach a given degree of cake solids with a particular blend or type of solids (USEPA, 1987). It is also helpful to keep track of pressing time and filtrate quality to gauge performance of the filter cloths.

COSTS

Recessed-plate filter presses carry relatively high capital costs compared with other mechanical dewatering methods due to equipment and the need for standby capability for cake handling. Operation and maintenance (O&M) costs may also be relatively high. O&M cost elements include chemicals (for sludge conditioning and precoating), cloth washing and replacement, and operator activity. Operation costs for the filter press facilities at Williamsburg, Virginia total approximately $40/dry ton and maintenance costs amount to $12/dry ton (1987 costs) (WEF 1992).

REFERENCES

Other Related Fact Sheets

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

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

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

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

Centrifugal Dewatering and Thickening
EPA-832-F-00-053
September 2000

Belt Filter Press
EPA-832-F-00-057
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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5. USEPA, 1987. Design Manual: Dewatering Municipal Wastewater Sludges.

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