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EPA

Design Information Report

Recessed Plate Filter Presses

The U.S. Environmental Protection Agency has undertaken a program to help municipalities and engineers avoid problems in wastewater treatment facility design and operation. A series of Design Information Reports is being produced that identifies frequently occurring process design and operational problems and describes remedial measures and design approaches used to solve these problems. The intent is not to establish new design practices, but to concisely document improved design and operational procedures that have been developed and successfully demonstrated in field experiences.

With an increased emphasis being placed on environmental concerns associated with the disposal of sludges from wastewater treatment facilities, there has been a growing awareness of the need for improved efficiency and reliability in the performance of in-plant sludge treatment processes. The dewatering of sludges is an important step in the total sludge processing train, and can have a negative impact on the effectiveness and cost of subsequent sludge treatment processes. Recessed plate filter presses are sometimes used when a high solids content sludge cake is desired, and they are often considered as an alternative sludge dewatering device when upgrading an existing facility or planning a new facility.

Introduction

This report presents current problems associated with the selection, design and operation of recessed plate filter press systems at municipal wastewater treatment facilities. It discusses application of both fixed volume and variable volume recessed plate presses, as well as selection and application of auxiliary equipment associated with these presses. Major factors involved in successful application of recessed plate filter presses are simplicity and durability of the press; proper selection and application of auxiliary equipment; and proper selection of cloth filter media.

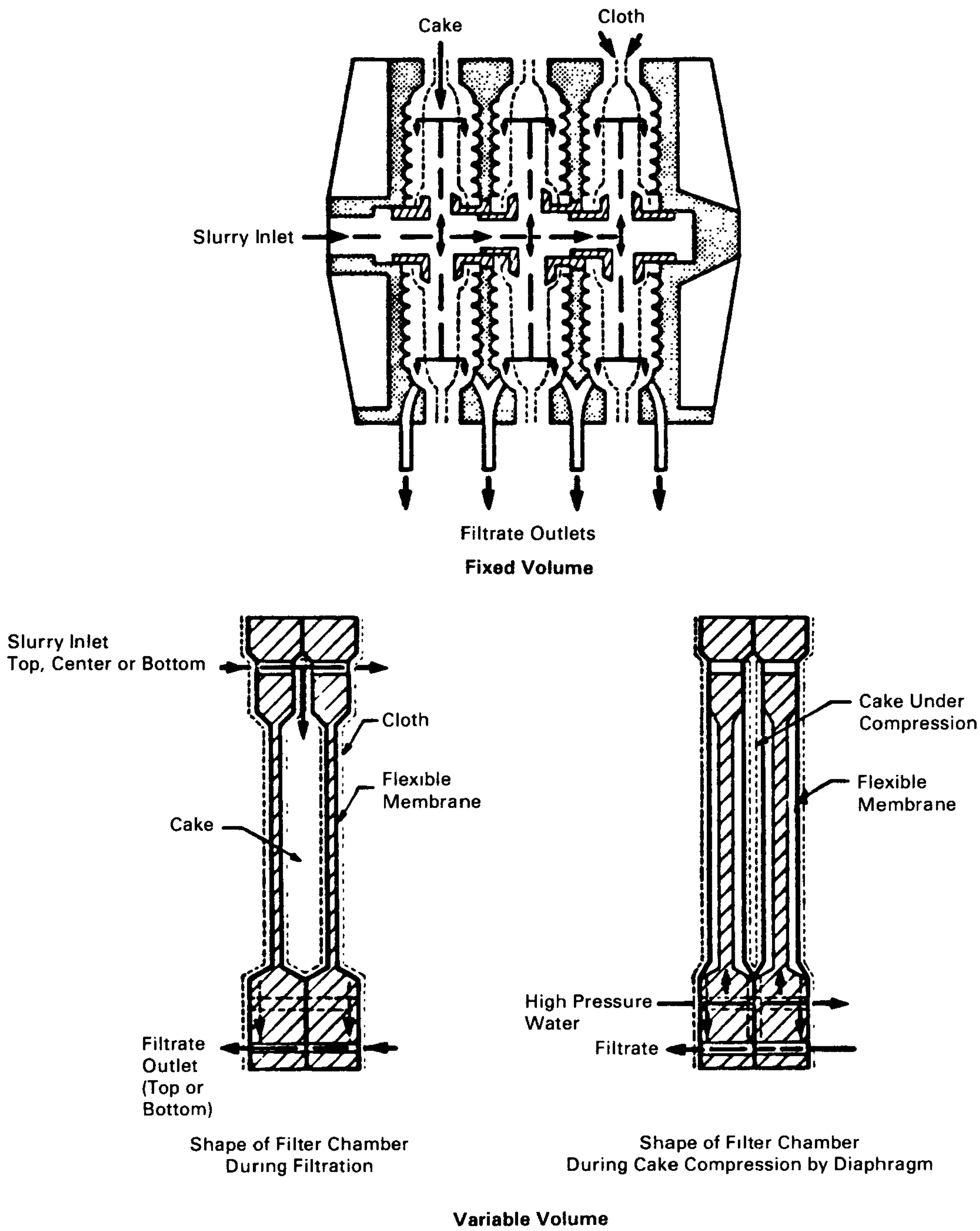
Recessed plate filter presses evolved from technology developed for sugar manufacturing (11), and have been successfully used in dewatering municipal sludges since the late 1800's. Introduced in the United States in the 1920's, there are currently 44 known recessed plate filter press installations in this country. There are presently nine major suppliers of this device in the United States. With this level of competition, improvements to the equipment and its operation are gradually being made and are expected to continue.

Equipment Description

Both fixed volume and variable volume recessed plate filter presses are available. The devices are used to dewater chemically conditioned sludge on a batch basis using mechanically-applied pressure to achieve high sludge cake solids content. Simplified cross sections of the devices are shown in Figure 1.

The fixed volume recessed plate filter press consists of a series of parallel plates, each fitted with a filter cloth and rigidly held together in a structural frame. Sludge is pumped into a series of chambers formed by recesses in the plates, which are held together by hydraulic or electro-mechanical screw type mechanisms. As the sludge is pumped into the press, the solids are captured within the chambers while excess water (filtrate) passes through the filter cloth and leaves the press through the filtrate collection system. The accumulation of sludge solids within the chambers causes the pressure in the sludge feed system (filtration pressure) to increase. The sludge feed pump continues to pump until reaching the terminal filtration pressure of no more than 100 psi for low pressure presses, or no more than 225 psi for high pressure presses. Once this pressure is reached, the pump will continue to maintain the terminal pressure as the filtrate continues to drain from the sludge. During the filtration cycle, the filtrate passes through the filter cloth into collection ports located at the corners of each plate and is usually discharged to a filtrate weir box at the head end of the press. Filtrate flow and quality can be monitored at this location.

Figure 1. Recessed Plate Filter Press Cross Sections[11]



The variable volume recessed plate filter press differs from a fixed volume press in that it utilizes a flexible membrane or diaphragm to provide a second squeezing phase to the sludge within each chamber after initial formation of the filter cake. At a predetermined filter press feed pump pressure, the space between the press plate and its flexible membrane will be filled with water to provide additional compression of the sludge.

In either type of press, the dewatering cycle is complete when filtrate is reduced to a minimum flow at the filtrate weir box and/or cycle time (determined by experience) expires. Before the filter plates are separated, the sludge feed pump is shut down and liquid sludge is cleared from the sludge feed port by the application of compressed air (core blowing). Core blowing keeps unprocessed wet sludge in the press core from running over the face of the filter plates when the plates are separated. A plate shifting mechanism controls the sludge cake discharging operation by allowing only one plate to be separated at a time. When the plates on a fixed volume press are separated, the weight of the sludge cake allows it to drop from the plates onto sludge handling facilities located beneath the press. On a variable volume press, cake release is enhanced by a mechanical system that shifts the filter cloth around the bottom of each plate and then back into position.

Typical performance data for recessed plate filter presses for various types of sludge are shown in Table 1. The sludge cake produced on recessed plate presses has the highest cake solids content of the currently available dewatering devices. For this reason, it is amenable to all dry sludge disposal methods. When recessed plate dewatering is followed by incineration, process integration considerations should recognize trade-offs between low moisture content of the sludge cake and the inert solids concentration resulting from the conditioning step. Conventionally conditioned sludge cake has a low moisture content but it can have a high inert solids level, while polymer conditioned sludge cake may have a higher moisture content but also a higher level of volatiles. Either conditioning step produces a cake of somewhat different characteristics, but both cakes are amenable to incineration with trade-offs between moisture content and inert solids.

In addition to the actual dewatering equipment discussed above, there is an interrelated system of auxiliary components that supports the operation of the recessed plate filter press. This auxiliary equipment includes:

1. Sludge Feed Pumps: These positive displacement pumps must be capable of delivering a wide range of pressures and flows. At the beginning of the filtration cycle the pumps deliver a maximum flow against a very low back pressure. As filtration progresses and the back pressure increases due to solids accumulation in the press, the flow rate drops to a very low rate at the terminal pressure. The pumping system includes specially designed flow control devices which automatically adjust flow rate with increasing pressure. Piston-membrane, hydraulic ram, and progressing cavity pumps have all been used for this service.
2. Chemical Conditioning. Conditioning of municipal sewage sludge can be achieved either by adding lime and ferric chloride, lime only, alum, or polymers or by adding ash or other granular materials. Lime and ferric chloride are most commonly used although polymer has been recently shown to be cost effective at some facilities.
3. Filter Cloth/Plate Washing System. High pressure washwater (1500 psi) is required to clean accumulated sludge from the filter cloths and plates.
4. Acid Washing. When lime is used to condition sludges, a hydrochloric acid washing system is normally provided to eliminate the build-up of lime scale on the equipment and in the associated piping.
5. Core Blowing. This system uses compressed air to blow liquid sludge out of the sludge feed ports

Table 1. Typical Dewatering Performance of Recessed Plate Filter Presses*

Type of Sludge	(% Solids)	Conditioner (% Lime)	($\% FeCl_3$)	Filter Cake (% Solids)	Cycle Time (Min) Fixed Volume	Variable Volume
Raw Primary	5-10	10	5	45	120	20
				50	90	--
Raw Primary with less than 50% WAS	3-8	10	5	40-45	150	--
				50	120	--
Raw Primary with more than 50% WAS	1-4	12	6	45	150	--
				50	120	--
Raw Primary with Trickling Filter	5-6	20	6	38	120	--
Raw WAS	4-5	15	7.5	35-45	150	--
				50	120	--
Digested Primary	8	30	6	40	120	--
Digested Primary with WAS:						
—less than 50% WAS	3-10	10	5	35-45	120	--
				50	90	--
—more than 50% WAS	2-6	15	7.5	40-50	150	--
				50	90	--
Heat Treated Primary with WAS	12-16	--	--	50-60	--	20

*Summary of data provided in references 5 and 10.

before the press is opened to help minimize the frequency of filter cloth and plate washing.

6. Precoating System. When sludge cake regularly adheres to the plates after the press in opened, a precoating system is used to improve cake release. This system pumps a slurry of ash or other similar substance to the filter to coat the filter cloths before the sludge introduced. A precoating system is not necessary on a variable volume press because cake release is assisted by a mechanical system that pulls the filter cloth down between the plates.

7. Prefilling System. Prior to pumping sludge to the press, it should be filled with effluent water to purge any trapped air from the press. Eliminating this step can sometimes result in the press being only partially filled during a cycle.

Design Considerations

The major components of the recessed plate filter press are its frame, plates, filter cloth, hydraulic plate closing mechanism, and plate shifting mechanism. The design and materials of construction vary among manufacturers.

The structural frame of the filter press consists of a fixed head, a moveable head, and a plate support system. The two most common types of plate support systems are the side bar and overhead types, as illustrated in Figure 2. The side bar type supports each side of the filter plate at a point slightly above the center of the plate. In the overhead type, the plates are hung from a support beam by a carriage assembly attached to the top center of each plate. Problems have been reported with the side bar type support related to frequent jamming of the plate shifting mechanism. The side bar design also prevents easy access to the plates during the cake discharging operations.

Presses are available with plates ranging in size from one-half meter square to two meters by three meters. They can be grouped to form as few as four to as many as 175 chambers. The materials most commonly available for filter plates of fixed volume presses are gray cast iron, ductile iron, rubber covered steel, epoxy coated steel, polypropylene and polyester. Materials used for filter plates of variable volume presses include polypropylene, ductile iron and steel. All of these plates are equipped with an elastomeric diaphragm. Ductile iron plates have proven to be the most durable on both types of press. Polypropylene plates less than 1.2 meters square have also been shown to have a relatively long life. The rubber covering on steel plates can crack and result in corrosion problems if the covering is not replaced when cracks are identified.

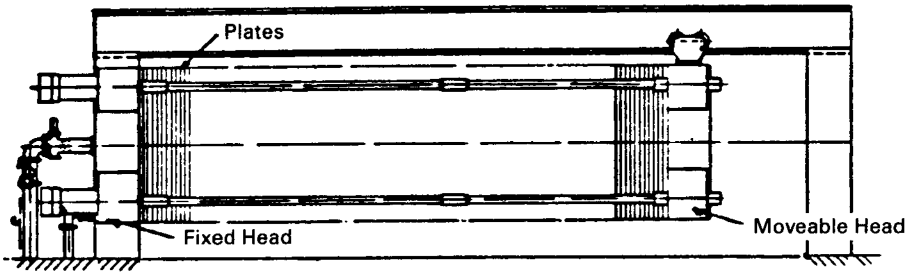
Filter cloth for sewage sludges is available with different permeabilities and is made of polypropylene, polyester, or nylon. Polypropylene is the most commonly used due to its resistence to both acid from the washing system and alkaline conditioning chemicals such as ferric chloride and lime. Polyester is more durable than the other materials since very little stretching will occur over the life of the cloth; however, it is the most expensive. Nylon should only be used where conditioning and/or cleaning chemicals are shown not to deteriorate the cloth. The permeability of filter cloth ranges from 30 to 100 cubic feet per minute (cfm). A permeability of 60 cfm is normally used. Filter cloth having monofilament construction and a satin weave has been shown to reduce cloth blinding and provide better cake release than other construction methods (i.e. multifilament, basket weave, and quill weave). Calendering, an optional process in cloth manufacturing that presses or irons the fibers in the cloth to produce a smooth finish, has improved cake release. A good quality polypropylene filter cloth will have a life between 4,000 and 10,000 cycles, depending on sludge type and press operation and maintenance.

Fixed volume presses are normally designed to operate at either 100 psi or 225 psi terminal pressure. These levels correspond to the pressure rating of commonly available piping. The operating terminal pressure of the press can be set below the maximum design pressure and is dependent on the cake solids concentration desired. Fixed volume press systems designed for a terminal pressure of 100 psi are normally used for lower dry solids applications where 30 to 35 percent dry solids are required. Press systems designed for 225 psi are normally used for higher dry solids applications where 40 to 50 percent dry solids are required. Variable volume presses are generally designed for 100-125 psi during the initial stage of the dewatering cycle followed by a final compression of 200-250 psi.

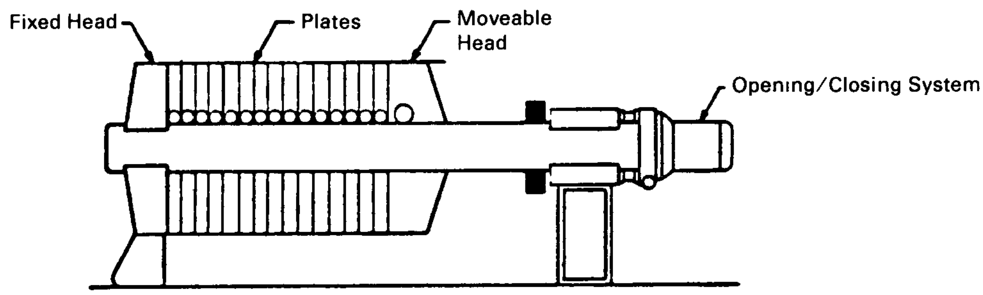
When designing a recessed plate filtration system together with its auxiliary equipment, other important features that should be considered include the following:

- To remove solids from the washwater and reduce spray bar orifice plugging, strainers should be provided on the high pressure washwater system. Mist suppression or control devices should be installed on spray bars.
- When a press has more than 75 filter chambers, sufficient piping and pumping flexibility should be provided in order to feed the press from both ends. This will decrease the time to fill the press, and reduce the chance of operating problems.
- In order to minimize the impact of falling sludge cake on the collection equipment, cake-breaking

Figure 2. Recessed Plate Filter Press Support Systems[11]



Overhead Support System



Side Bar Support System

Side View

bars should be installed under each filter to break-up the filter cake. In those installations where sludge cake drops onto a conveyor, the conveyor should be specified with additional rollers at this location for added durability.

- In order to facilitate filter plate removal, an overhead crane, monorail, or other device should be provided.
- Where feed sludge solids concentrations are likely to vary, sludge blending/thickening tanks are recommended prior to pumping sludge to the presses. Without these tanks sludge conditioning is more difficult to control and the time required for dewatering is harder to predict.
- In those installations where lime conditioning will be practiced, the ventilation system in the dewatering room should be adequately sized to handle ammonia odors. Ammonia odor can be objectionable, cause unhealthy side effects and impact operators' performance. A minimum ventilation rate of 6 air changes per hour for summer ventilation and 3 air changes per hour for winter ventilation should be considered. Other problems and remedies associated with lime handling systems are discussed in a recently published brochure by EPA. (12)
- When incineration follows dewatering, a shredder must be incorporated into the filter cake handling system. Filter cake pieces having any dimension larger than one inch will be only partially burned, forming clinkers. Clinker build-up can lead to jamming of the incinerator ash removal system.

Comparison of Press Types

In general, both types of presses can achieve the same range of filter cake dry solids. However, the variable volume press has a shorter cycle time and lower sludge throughput per cycle due to the second stage "squeezing" action that this press provides. In comparable applications, a fixed volume press of the same size and number of plates can produce two to four times the cake volume per cycle than can be produced on a variable volume basis. This volumetric limitation means that the variable volume press has to operate several more cycles per day than a fixed volume press in order to dewater the same volume of sludge.

In those applications where sludge is anticipated to be difficult to dewater, a variable volume press should be considered. Under these circumstances, a variable volume press may be more cost effective due to the cost savings obtained in the reduction of conditioning chemicals (due to the second squeezing phase) required over that necessary for a fixed volume press.

Another important consideration when choosing between the variable and fixed volume press is the mechanical complexity and estimated operation and maintenance requirements of each press. The variable volume press, which differs in design complexity among the different manufacturers, is a far more mechanically complex machine than the fixed volume press and it requires more operator attention and greater maintenance. Table 2 presents a summary of the advantages and disadvantages of fixed and variable volume presses that should be considered in the selection and application of this equipment.

Problem Areas and Potential Solutions

The major problems associated with the design and operation of recessed plate filter presses can be categorized within the following areas:

- Equipment quality
- Operational concerns
- Process integration
- Auxilliary system selection

Equipment Quality Problems

Equipment problems involve filter plate deflection, rapid filter cloth wearing, deteriorating stay-bosses, and defective plate shifter mechanisms.

Plate Deflection—Plate deflection problems generally result in plate breakage. These problems are most common with polypropylene and gray cast iron plates. In general, the life of a polypropylene plate that is larger than 1.2m square has been shown to be approximately 5 to 7 years. This is a relatively short life when compared with fixed-volume recessed plate installations using ductile iron plates for more than 35 years without any plate breakage. The major causes of plate deflection and associated remedial measures are shown in Table 3.

Filter Cloth Wear—The wearing of filter cloth in the area of the stay bosses is a frequently reported problem. The cylindrical stay bosses are interior supports in the recessed area of the plate. These supports are located directly opposing each other on either side of the chamber that is formed by the plates. As the plates undergo increasing pressure the stay bosses butt up against each other and prevent excessive plate deflection, ensuring a uniform cake thickness. The minor plate deflection that does occur produces a rubbing action at the stay bosses causing the filter cloth to wear. Remedial measures include either:

(1) Use of sewn-in reinforcement patches on the filter cloth in the area of each stay boss, or

Table 2. Advantages and Disadvantages of Fixed Volume and Variable Volume Recessed Plate Filter Presses

Type of Filter Press	Advantages	Disadvantages
Fixed Volume	• Higher volumetric capacity requires fewer dewatering cycles per day • Less complex instrumentation • Fewer moving parts • Longer plate life • Lower maintenance	• Dewaters only well conditioned sludges • More chemicals required for conditioning • Longer cycle time
Variable Volume	• Dewaters marginally conditioned sludges • Fewer chemicals required for conditioning • Shorter cycle time • Precoating system is not required	• Limited volumetric capacity, requires more cycles per day • Mechanically complex • Complex instrumentation • Labor intensive filter cloth replacement • Shorter plate life • Higher maintenance

Table 3. Causes of and Remedial Measures for Plate Deflection

Causes	Remedial Measures
1. High differential pressure across plates	1. Reduce operating pressure of high pressure presses to 150 psi. Use polypropylene plates 1 2 m square and smaller which have not exhibited this problem.
2. Use of a center feed system on variable-volume presses with polypropylene plates.	2. Avoid the selection of center feed systems in new plant design. In existing plants, use good sludge feed techniques and maintain good housekeeping practices
3. Residual sludge build-up on plates.	3. Increase frequency of plate washing.
4. Uneven sludge distribution and cake formation.	4. Improve sludge feed distribution as summarized in Table 4.

(2) Use of stainless steel protective covers which fit directly over the filter cloth and protect the filter cloth from wear, help keep the filter cloth in place, and minimize filter cloth stretching. The covers conform to the shape of the stay boss and are fastened at their centers with a machine screw, threaded into the stay boss.

Stay Boss Deterioration—The deterioration of rubber stay bosses is associated with deflection of the steel plates. Once the stay bosses have deteriorated, increased flexing of plates will ultimately lead to breakage. Consequently, it is advisable and economical to repair deteriorated stay bosses as soon as possible. Replacement of stay bosses and the entire rubber covering of the filter plate can be performed at a fraction of the cost of an entirely new plate. Deterioration of stay bosses can be minimized by following the remedial measures discussed under Plate Deflection, or by use of stainless steel covers.

Defective Plate Shifter Mechanism—On some filters, a defective plate shifter mechanism may move several plates at once. When this occurs the operator must manually separate the plates to remove sludge cake and clear the plates, thus increasing the cycle time of the dewatering operation. This problem is a design deficiency that requires corrective modification to the plate shifter mechanism. In some cases, field modifications have been made by plant personnel. These modifications include braising a catch onto the plate shifter which prevents it from attaching to more than one plate at a time. However, because of the equipment stresses involved during this part of the dewatering operation, such a modification should not be made without the consultation and evaluation of the equipment manufacturer.

Operational Concerns

Problems related to operation of recessed plate filter presses include nonuniform feed sludge distribution, improper sludge conditioning, poor cake release, inoperable or disconnected safety curtains, inability to estimate cycle completion, and lime scaling. Although many of these problems can be related to other problem areas, particularly equipment design, it is believed that they are most easily solved in existing facilities by improved operating practices.

Sludge Feed Distribution—Unequal distribution of feed sludge can impart a pressure differential between adjacent filter press plates, causing plate deflection. Excessive deflection will ultimately cause the plates to fail, stay bosses to deteriorate, and filter cloth to wear out. In addition, unequal feed sludge distribution results in a low cake solids concentration due to incomplete cake formation. The causes of this problem and the remedial measures taken to solve unequal distribution of feed sludge are shown in Table 4. Prefiltration, stated as one cause in this table, generally occurs on presses with more than 75 plates and/or when air is trapped in the press. When prefiltration occurs, sludge in the initial chambers begins to filter before downstream chambers are filled.

Table 4. Causes and Remedial Measures for Unequal Distribution of Feed Sludge

Causes	Remedial Measures
1. Prefiltration of sludge at feed end of press	1 Prefill press with plant effluent followed by rapid filling with feed sludge
2 Cloth Blinding	2 a. Modify sludge feed rate b Experiment with different types of filter cloth (see section on Design Considerations) c. Optimize uniformity of sludge feed by proper storage and blending
3. Poorly conditioned sludge	3. Perform capillary suction time (CST) test or Buchner funnel test on conditioned sludge prior to feeding sludge to filter

Sludge Conditioning Tests—A capillary suction time (CST) test is a rapid, easy, inexpensive and reproducible method for determining whether a sludge is properly conditioned. This test measures the time it takes to wet a given area of filter paper with filtrate that is withdrawn from a sludge sample by the capillary forces of the filter paper. The shorter the measured time the better is the filterability of the sludge. If the approximate CST time is known for optimally conditioned sludge, the operator can test sludge samples prior to dewatering to determine whether they have been properly conditioned. The Buchner funnel test also measures sludge filterability. Although this test requires some additional work to get the desired results, it can be used effectively in avoiding problems due to poorly conditioned sludge.

Poor Filter Cake Release—The causes and solutions associated with poor filter cake release are shown in Table 5. Although operators can manually remove adhering sludge from the press (generally with a paddle), this is not an optimum solution. This problem should be avoided because it results in increased cycle time that is required, increased frequency of plate and filter cloth washing that is needed, and the possibility of damaging the filter cloth.

Safety Curtain Reliability—The safety curtain is designed to protect the operator from injury when the plate shifter mechanism is operating. Often referred to as a "light curtain", it consists of a series of narrow beamed lights at one end of the press, focused on a series of matching photocells at the opposite end of

Table 5. Causes of and Remedial Measures for Poor Cake Release

Causes	Remedial Measures
1. Worn or improper filter cloth	1. a. Replace worn filter cloth b Experiment with filter cloths of different materials, permeability ratings, and surface finish and select more applicable cloth
2. Poorly conditioned sludge	2. Optimize sludge conditioning by performing CST or Buchner funnel test on feed sludge.
3. Lack of precoating of filter cloth	3. Utilize or incorporate a precoating system

the press. If the light curtain is interrupted by the operator reaching into the press, the plate shifting operation stops automatically. Due to equipment corrosion, electrical failure, faulty alignment of the transmitter and receiver, or simply inactivation by operators, many light curtains are often not in use. This equipment performs an important safety function and its disabling should not be permitted. Additional training, where necessary, should be provided to operators on proper press operation with this safety system functioning.

Determination of Dewatering Cycle Completion—Since the formation of filter cake in the filter press is not observable, the operator relies on either one or both of the following parameters to determine the completion of a cycle:

1. *Elapsed Time.* Most manufacturers of this equipment provide a time clock in their control panel that can be set based on expected length of cycle. After the set period of time has expired, an alarm will sound to notify the operator the cycle is complete.
2. *Filtrate Flow.* This method entails the operator monitoring the quantity of filtrate flow through the weir box after the press has attained operating pressure. Once filtrate flow has been reduced to a minimum (determined by experience) the cycle is considered complete.

The successful use of either timing method requires considerable operator experience. The control of press operation relies on interrelationships among process variables and the type and performance of equipment, and a lack of experience can result in poorly dewatered sludge. Consequently, the operator must be aware of the normal range of operating parameters discussed above as well as (a) time required to fill the press, (b) degree of sludge conditioning based on CST or Buchner funnel test results, and (c) filtrate quality. Because raw sludge characteristics affect press performance, the operator should also monitor such data as mix of primary and secondary sludge, and sludge age. If these parameters vary from the normal range, the operator should make adjustments to conditioning chemicals or cycle time during the cycle and determine potential problems and solutions before the next cycle.

Lime Scaling—When lime is used for sludge conditioning lime scaling has been reported to occur in the chemical and sludge feed piping, on the filter cloth, and on the filter plates. If the scale is allowed to accumulate, cycle time may be increased, sludge throughput can be reduced, cake release problems can occur, cake dryness can be affected, and/or the filter cloth can blind with sludge. It is often cost-effective in those facilities where lime scaling is a problem to add an acid wash system to periodically remove the lime scale buildup.

The feasibility and cost-effectiveness of other conditioning chemicals such as polymers could be considered to eliminate or reduce lime use. Some installations have been successful in converting from lime and ferric chloride to a highly charged cationic polymer for conditioning sludge prior to dewatering. However, despite some successes and a possible cost savings (one facility reported a 68 percent conditioning chemical cost savings), other facilities attempting to switch to polymers have not achieved adequate dewatering and have had to revert to other conditioning chemicals.

Process Integration

Because recessed plate presses are capable of handling nearly all types and mixtures of sludges, and because their batch operation allows modification of operating criteria with changes in sludge feed characteristics, few problems are related to process integration. The major problems that do occur include improper removal or grinding of rags, and nonuniform sludge feed characteristics.

Rag Problems—Rags carried through the wastewater treatment process to the dewatering equipment will adversely impact sludge conditioning and eventually plug the in-line mixers in the sludge feed lines. To clear the feed lines, the dewatering process must be temporarily shut down. Rags can also interfere with plate closure and cause deflection. Consequently, it is essential that upstream screening and/or grinding equipment is properly operated and maintained. Where problems persist, operators should consider the addition of more effective screening and/or disintegration equipment (i.e., mechanical bar screens in the headworks and/or grinders on sludge feed pumps).

Sludge Feed Continuity—Although recessed plate filter press operation can be modified to accommodate sludges of varied characteristics, press performance can be most efficiently maintained if the sludge feed characteristics do not vary abruptly. Sludges should be blended prior to the addition of conditioning chemicals and, where possible, small (one to two hour detention time) holding tanks should be provided prior to dewatering to provide a representative sample for testing. This determines adjustments needed in the conditioning process to provide an optimum feed to the filter.

Auxiliary Systems

The problems associated with the auxiliary systems for recessed plate presses include corrosion and failure of pneumatic cylinders, and excessive misting by filter media washing systems.

Pneumatic Cylinder Corrosion—High moisture content of the compressed air used in pneumatic cylinders for recessed plate presses can cause corrosion of the cylinders and ultimately lead to failure. This problem can easily be solved by the addition of air drying equipment to the compressed air system.

Excessive Misting—Excessive misting during the plate washing operation has caused corrosion and subsequent failure of nearby mechanical devices, instrumentation, and electrical devices. Some plate wash systems are provided with brush assemblies around the spray bar which effectively contain the mist. Where brushes have not been used, spray curtains have been installed and have successfully contained the spray.

Summary

The design of a recessed plate filter press system for municipal sludge requires careful consideration of the need to attain the degree of dryness that can be achieved with such devices. When this dewatering alternative is selected, the designer and operator must keep in mind that successful operation is dependent upon a number of key factors, including system integration, correct equipment design and operation, and proper sludge conditioning.

The following considerations and recommendations should be included in the design and operation of recessed plate filter press facilities:

1. Equipment
   - Fixed volume presses are less complex and more easily maintained than variable volume presses.
   - Variable volume presses have features that provide good results particularly when used on sludges that are difficult to dewater.
   - Filter precoating and prefilling systems should be provided.
   - Plate deflection problems can be reduced by proper selection of plate material.
   - Filter cloth wear can be reduced by reinforcing the cloth and/or utilizing protective cups at stay bosses.
   - Reliable plate shifting mechanisms should be provided.
   - Sludge blending and storage tanks should be included prior to dewatering to assure sludge feed continuity.
2. Operations
   - Positive methods of rag removal and/or disintegration should be provided.
   - Proper sludge conditioning should be achieved through use of CST or Buchner funnel tests.
   - Safety devices such as light curtains should be installed, used, and maintained.
   - **Unequal distribution of sludge within the presses causes equipment and performance problems and should be avoided.**
   - The required dewatering time should be estimated and monitored to assure that adequate time is allowed.
   - Start-up and on-going operator training should be required.
3. Auxiliary Systems
   - A mist suppression system should be provided on spray bars
   - A core blowing system to back-flush the sludge feed lines should be provided to minimize plate washing and ease housekeeping.
   - Where lime is utilized, an acid wash system for scale removal is recommended.
   - An automatic high pressure, filter cloth/plate washing system should be included.
   - Washwater systems should include strainers to remove solids.
   - To minimize safety and corrosion concerns, ventilation should be adequate and odor control should be practiced.

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