How The Filter Press Works

Filter presses were introduced at the turn of the century and have been around for many years mainly dewatering waste sludge. They have been used in numerous applications so much so that it is referred to as the “work horse” of the filtration world. Typical applications being: -

1. Sewage Sludge
2. Potable water sludge
3. Dyestuffs
4. Colours and Pigments
5. Washed Coal Tailings
6. Heavy metal and Plating shop effluents
7. Brewing
8. Most Industrial Effluents

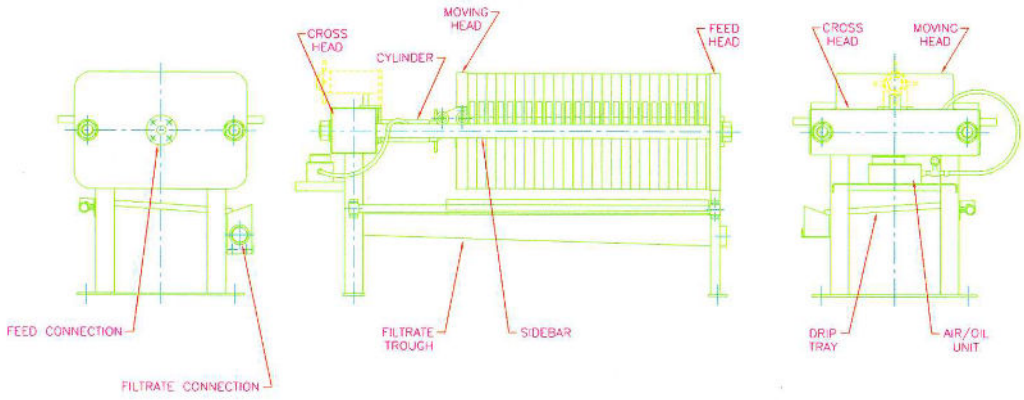
……. there are many others.

In recent years, several factors, including the Statutory Legislation controlling discharge to waste of unsuitable effluents, shortage of land for lagoons or drying beds, shortage of water and in some industries a search for additional by-products of a process, have brought about a new appraisal of filter presses.

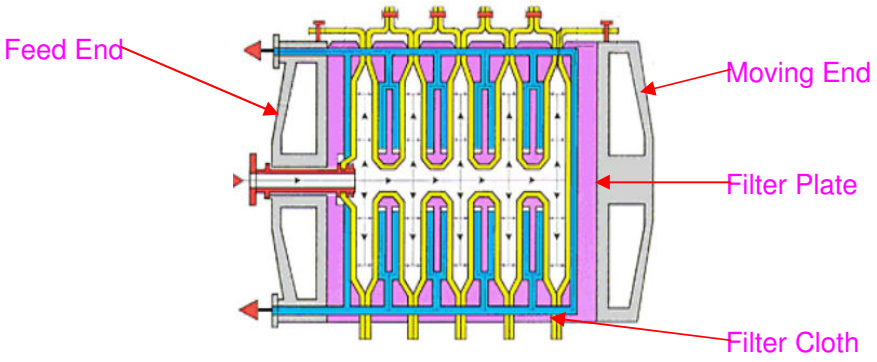
Where the material to be filtered contains finely divided solids especially in the sub-sieve and sub-micron sizes, and where it is difficult to separate the liquid from the solid, a greater force is required to effect the separation efficiently. The filter press can produce a higher pressure than either the centrifuge or the rotary vacuum filter or belt filter. It is often the only unit suitable for filtering slurries, which have low filtration rates.

They were considered labour intensive machines hence they did not find much acceptance in the sophisticated and highly automated process industries. It was not until sometime in the 1960’s that this image was changed by the introduction of advanced mechanisms that were oriented towards obtaining low moisture cakes that discharge automatically and enable cloth washing on a periodic basis.

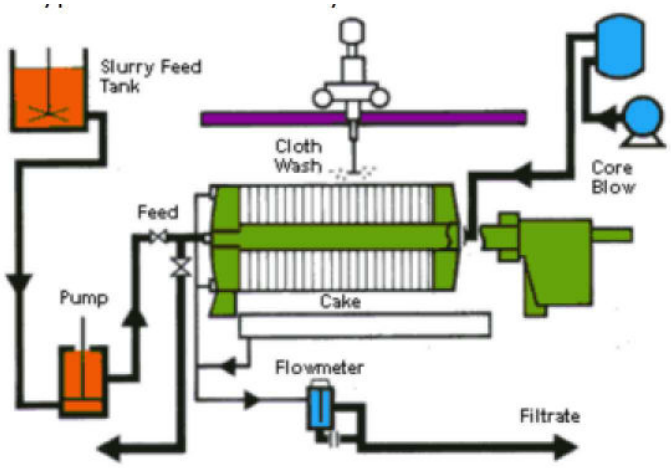
The Filter press consists of a head and follower that contain in between a pack of vertical rectangular plates.



Each plate is dressed with filter cloth on both sides and, once pressed together, they form a series of chambers that depend on the number of plates. The entire pack of plates is supported by side or overhead beams.
The head serves as a fixed end to which the feed and filtrate pipes are connected, and the follower moves along the beams and presses the plates together during the filtration cycle by a hydraulic or mechanical mechanism.



The plates have generally a centered feed port that passes through the entire length of the filter press so that all the chambers of the plate pack are connected together. Likewise, four corner ports connect all the plates and collect the mother and wash filtrates in a “closed discharge” towards outlets that are located on the same side as the feed inlet. Some filter presses have plates that are fitted with cocks at their lower side so that the filtrate flows in an “open discharge” to a trough and serve as “tell tales” on the condition of the filter cloth by the clarity of the filtrate that passes through each chamber. The disadvantage of this arrangement is that it cannot be used with filtrates that are toxic, flammable or volatile.
A typical flow scheme may look like this:



Alternative Types of Unit

There are two main types of machine

Side Bar Filter Press

(From 250mm square to 2m square)

The side bar suspension design incorporates plates each fitted with two handles, one on each side located near their mid section, which rest on side bars. The side bars connect to fixed end plates to form a press framework; one of these end plates, the cross head or tightening head, carries the closing gear which bears on the follower plate, itself freely supported on the side bars, causing the follower plate and the plates and frames to close against the second fixed end plate, the head. The closing mechanism may be provided by a number of alternatives, including simple capstan gears for small filters, ratchet capstan gears, motorised screws and hydraulically actuated rams; the latter two alternatives are generally used for larger sized filters.

Overhead Suspension Design

(From 800mm sq to 2000 square)

This design incorporates two end plates one being fixed where the recessed plates are suspended from an overhead beam and is free to move along the beam; their movement along the beam is facilitated by geared travelling carriages. The plates are suspended from the beam using roller bearing suspensions and special track bracket assemblies, which ensure that the movement along the beam is aligned.

The press is normally closed by a system of hydraulic jack assemblies mounted respectively on the king end; the piston rods from the jack assemblies are connected by coupling nuts to tie bars which pass through bosses in the other end plate, the queen end, and are locked on this end plate by clamp nuts. When hydraulic system is pressurised and the press becomes closed it is locked in the closed position either by manual lock nuts at the king end or by a self-sustaining hydraulic pressure system. The

individual plates need to be returned to their initial position before re-closing the press. Each plate is moved sufficiently far along the beam to allow the cake to be discharge and to adjust the cloths to remove any adhering cake; after repeating the procedure for each plate the press is immediately ready for re-closing in readiness for the next filtration cycle. Plate handling is thereby eased and downtime and cloth wear is reduced.

Mechanised Filter Presses

The need to reduce manpower on process plants and to ease the nature of the work involved has called for mechanisation and automation of filter presses. Both of the above types can be mechanised.

The development of overhead suspension designs makes it possible to operate these presses by one man and to maintain good operational efficiency. Mechanised operating systems are available for plate movement and press opening and closing – safety systems can also be incorporated – but it has been established in practice that manual operation is faster, capital cost is lower and the manual effort required is not excessive.

The side bar suspension press can be fully mechanised and provides automatic means of closing the plates together. Sealing the press at a pre-determined pressure, moving each plate individually to afford cake discharge. Controlling the movement to minimise filter cloth wear due to impact and providing a safety system whereby electric power is cut off if an operator approaches the filter while the plate transfer mechanism or the closing mechanism is in operation.

The present day filter presses, as mentioned previously, are equipped with features that enable fully automatic operation controlled by PLC's.
The main features are:
• Shuttle shifters that separate the plates one by one for cake discharge at a rate of 5-6 seconds per plate. A special design of the shifting mechanism ensures that two adjacent plates are not pulled together due to sticky cakes.
• Shakers that subject the plate to vibrations and assist in discharging the cake.
• Cloth showers with movable manifolds and high impact jets for intensive cloth washing.

Precoating and Body-Aid

Often special measures are taken to ease cake discharge and enhance filtration.

The measures are:

- Precoating of plates
- Addition of Body Aid to feed slurry

Precoating the filter plates prior to introducing the feed is done only in the following cases:

- When the contaminants are gelatinous and sticky it forms a barrier that avoids cloth blinding. Likewise, the interface between the precoat and the cloth departs readily so the cake discharges leaving a clean cloth.
- When a clear filtrate is required immediately after the filtration cycle commences otherwise recirculation must be employed until a clear filtrate is obtained.

Once the pre-coating stage is completed the process slurry is pumped into the filter, the forming cake is retained on the plates and the filtrate flows to further processing. When the solids are fine and slow to filter a body-aid is added to the feed slurry in order to enhance cake permeability. However, it should be kept in mind that the addition of body-aid increases the solids concentration in the feed, so it occupies additional volume between the plates and increases the amount of cake for disposal. Likewise, for all those applications when the cake is the product, pre-coat and filter-aid may not be used since they mix and discharge together with the cake.

The Plates

For many years filter presses, also called Plate and Frame, have been used. In the plate and frame type of press chambers are formed by the use of a hollow frame, which is placed between two plates whose rim, or joint surfaces are nearly flush with their drainage surfaces. The slurry to be filtered is fed into the press through a manifold formed by ports in each plate and frame and delivered into each frame by suitable connecting ports. The solids are retained within the hollow frame whilst filtrate delivers through the media into a collection manifold by way of additional ports in the plates or through drain cocks or directional bibs. The first filter plates to be used were manufactured from either cast iron or wood.

These Plate and Frame Filter presses had many sealing surfaces, which were the main cause for leakages so the introduction of Recessed Plates has cut the number of surfaces in half and reduced the problem of drippings. With the development of plastics a high-density heat stabilised Polypropylene filter plate became available. This had distinct advantages over the other plates. Since it is lighter in weight, it does not need any maintenance in respect to corrosion. This is the plate material that is now most commonly used.

Obviously, there are applications where this material cannot be used.
E.g. high temperature oil and certain solvents. In these cases, it is necessary to revert to the old cast iron plate material or alternative material.

In the recessed type of press the recess is formed by a raised edge, which stands above the drainage surface, and the thickness of cake formed is therefore twice the depth of the recess on individual plates. The slurry to be filtered is normally fed into the filter press through a central hole that feeds each chamber at the same time. The solids are retained within the recess hollow chamber and the filtrate passes through the media into an internal manifold or away through drain cocks or directional bibs.

The development of Recessed Plates has gone hand in hand with advances in cloth technology, which enabled 3-dimensional stretching as opposed to Plate and Frame where the cloth remains in one plain.
Present recess depths are 12.5, 16, 20 and 25 mm so the corresponding cake thicknesses are 25, 32, 40 and 50 mm at maximum filling. Filter presses are built for operating pressures of 7, 10 and 15 bar. Squeezing of the cakes by air or (more commonly) water pressure exerted on specially designed membrane plates is also available as an option. The largest available plates are 2.1 by 2.1 meters so the hydraulic pressure system that holds the closing force of the plates is designed accordingly. Filter press plates are generally manufactured in high-density polypropylene but are also available in other materials such as cast iron, aluminum alloys, high-density polypropylene and PVDF. The major area of development, apart from automation, was in the design of the plates since thermoplastics have enabled new structural concepts, which were not possible with metallic plates.

The special features are:
• Lower plate weight has reduced the downtime for shuttle shifting during the cake discharge mode.

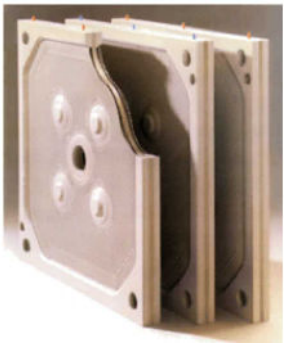
• Effective filtration area has gone up since with the largest available plates of 2.1 by 2.1 meters, having a 20 mm recess and 150 chambers, the area is about 1100 m2 with a cake capacity of over 20 m3.

• The introduction of water pressure, or air to a lesser extent, from the backside of flexible membranes reduces chamber volume and squeezes the cake yielding a further lowering of the moisture content. The filter press may be arranged as a mixed pack of flush and membrane plates, full flush or full membrane pack depending on the application.

The membrane plate is a significant technological development of the standard recessed plate. In our process every plate has a flexible face, which covers both sides of the plate.

The fundamental principle of membrane operation realises that approximately 75 to 80 per cent of the product to be filtered passes through the filter press in the first third of the cycle time. At this point, in each chamber two “half” cakes have been built up. Press feeding is stopped, and the flexible membrane outer surfaces are inflated by applying

compressed air pressure (or water) behind the membrane surfaces. The two halves of cake in each chamber are then squeezed together, under pressure, forming a single cake of a very homogenous consistency.



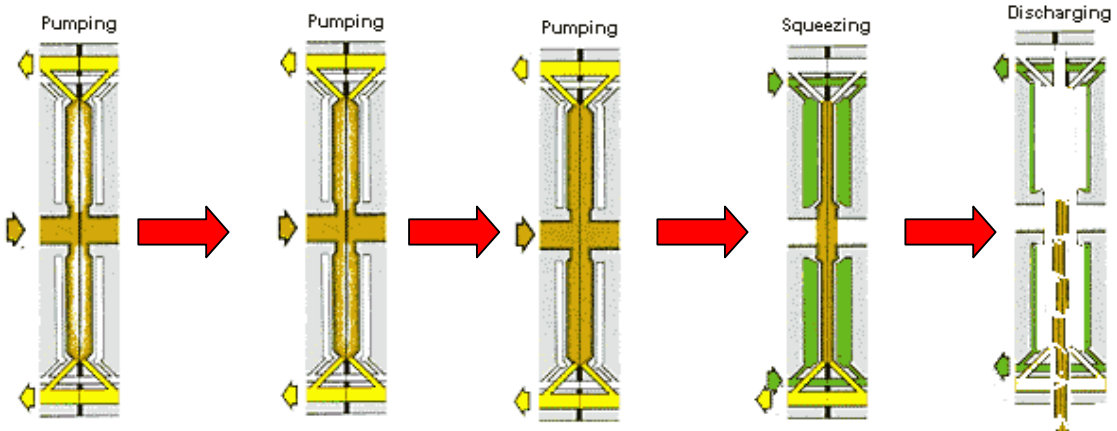
Typical membrane plates are shown in the photograph to the left.

Most plates are extruded in polypropylene, which withstands temperatures of 80-85C. Operating at higher temperatures will warp the plates and leakage or even squirts can be dangerous at such high temperatures.

Selection Criteria

Filter presses are best selected in the following instances:
• When a very low moisture content is required for thermal cake drying or incineration.
• When high filtrate clarity is required for polishing applications.
• When good cake release assisted by squeezing is required.
• When the cake needs to be disposed of as land fill.
• When large filtration areas are required in a limited space.
They should be selected with care:
• When filtering saturated brines since the plates cool-off during cake discharge and require preheating prior to feeding the process slurry. For such brines autoclaved filters such as Horizontal Plates, Vertical Leaf or Candle Filters are better suited as they can be steam jacketed.
• When there is a risk of environmental hazard from toxic, flammable or volatile cakes when the plates are opened for discharge at the end of each cycle. Again, the autoclaved filters are better suited.
• When efficient washing is required since with a chamber filled with cake the wash water may not reach all its surface causing an uneven displacement. This, however, should present no problem when a gap is left between the formed cakes within a chamber so that the wash water is distributed evenly over the cake and reaches its entire surface. Washing efficiency is often enhanced with membrane squeeze.

Operational Sequence



Squeezing for membrane sequence only

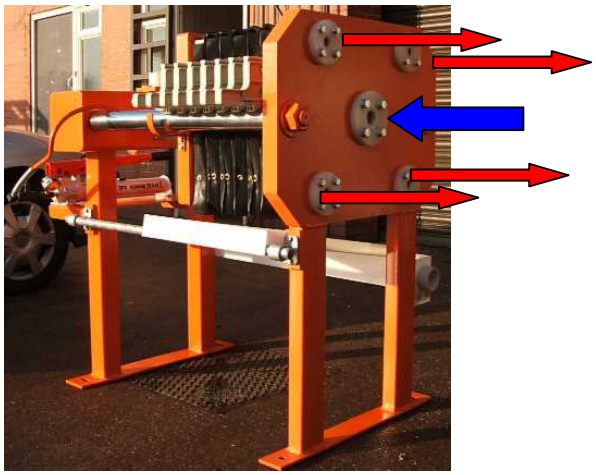
Filter press without membrane plates:

• Slurry is pumped and fills the chambers at a high flow rate and low pressure which gradually builds-up as the cake forms in the chamber. As the pressure rises the flow rate reduces.
• When optimum pressure is achieved the flow of filtrate will virtually or completely cease.
• The wet core and pressure from the machine is relieved by means of a pressure relief valve, mounted in the feed line, prior to the filter press being opened.
• The filter press is ready for cake discharge.
• The hydraulic plate closing piston retracts together with the follower.
• The plates can then be moved one by one either mechanically or manually towards the follower and the cake discharges.
• Once the cakes are all discharged the filter press can be closed for the start of the next filtration cycle

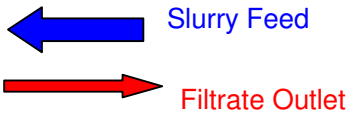
Filter press with membrane plates:

Slurry is pumped and fills the chambers at a high flow rate and low pressure, which gradually builds-up, as the cake gets thicker.
• The membranes, of empty chamber type plates, are pressed back to allow cake formation.

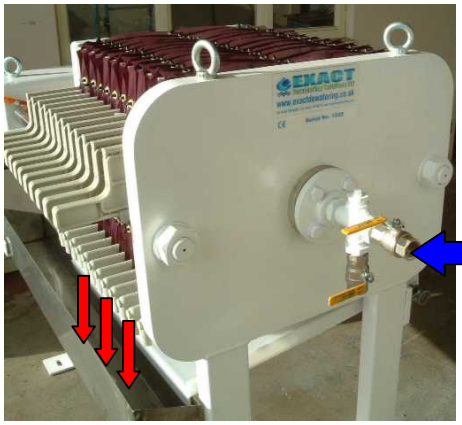
• When the optimum pressure is achieved the cake is pre-squeezed. This is done by means of inflating the face of the filter plate using compresses air or by pumping water to the backside of the membranes. This applies a mechanical pressure to the filter cake displacing further liquid trapped within the structure of the cake. This is only effective if the material responds to mechanical compression and is not compatible with all filter cakes.
• Air is used for lower pressure squeezing whereas water is used for pressures up to 20 bar
• Pressure is relieved from the membrane system
• The wet core and pressure from the machine is relieved by means of a pressure relief valve, mounted in the feed line, prior to the filter press being opened.
• The drip trays open and are ready for cake discharge
• The hydraulic plate closing piston retracts together with the follower.
• The plates can then be moved one by one either mechanically or manually towards the follower and the cake discharges.
• Once the cakes are all discharged the filter press can be closed for the start of the next filtration cycle



Closed Filtrate Discharge



Filter plates are drained by means of 4 corner ports emerging at the feed head of the filter press, which can be connected by a common manifold and piped away.



Slurry Feed

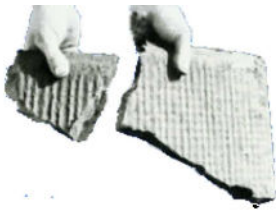
Filtrate Outlet

Pressure Relief

Filter plates are drained via individual bibs located on the bottom corner of each plate into a launder trough running the length of the machine.

Open Filtrate/ Bib Discharge

Cake Disposal



Cakes may be discharged into bins that are trucked away or transported with a belt conveyor. With very large filter presses a well-formed cake may weigh 200-300 Kg per chamber and when it falls into a bin or onto a belt conveyor in one solid piece the impact is very high. Hence, special measures are required to break and de-lump the solid hard cake and, for belt conveyors, it is also recommended to increase the number of belt support rollers below the discharge chute at the point of impact.

Maintenance

The basic filter press by itself requires very little maintenance.

The main areas that may require occasional attention are:

1 Filter cloths

The cloth must be checked for holes. Damaged cloths will result in slurry passing to the clean filtrate side of the filter press. This will be indicated by dirty filtrate running from the filtrate ports or bibs. The bib style plate makes it easier to identify where a cloth is damaged.
The sealing edges that surround the cloth and seal between adjacent plates should be checked for damage and solids build up as this will result in edge leakage.

Filter cloths need to be cleaned regularly to prevent solid build up on sealing faces and improve overall filtration performance. Cleaning will increase the overall life of the filter cloth.

2 Hydraulics

The filter press is kept closed by means of a hydraulic cylinder. The exposed part of the chrome piston rod needs to be kept free from debris and corrosion. Occasionally it may be necessary to renew hydraulic seals.