Liquid Pressure Filters

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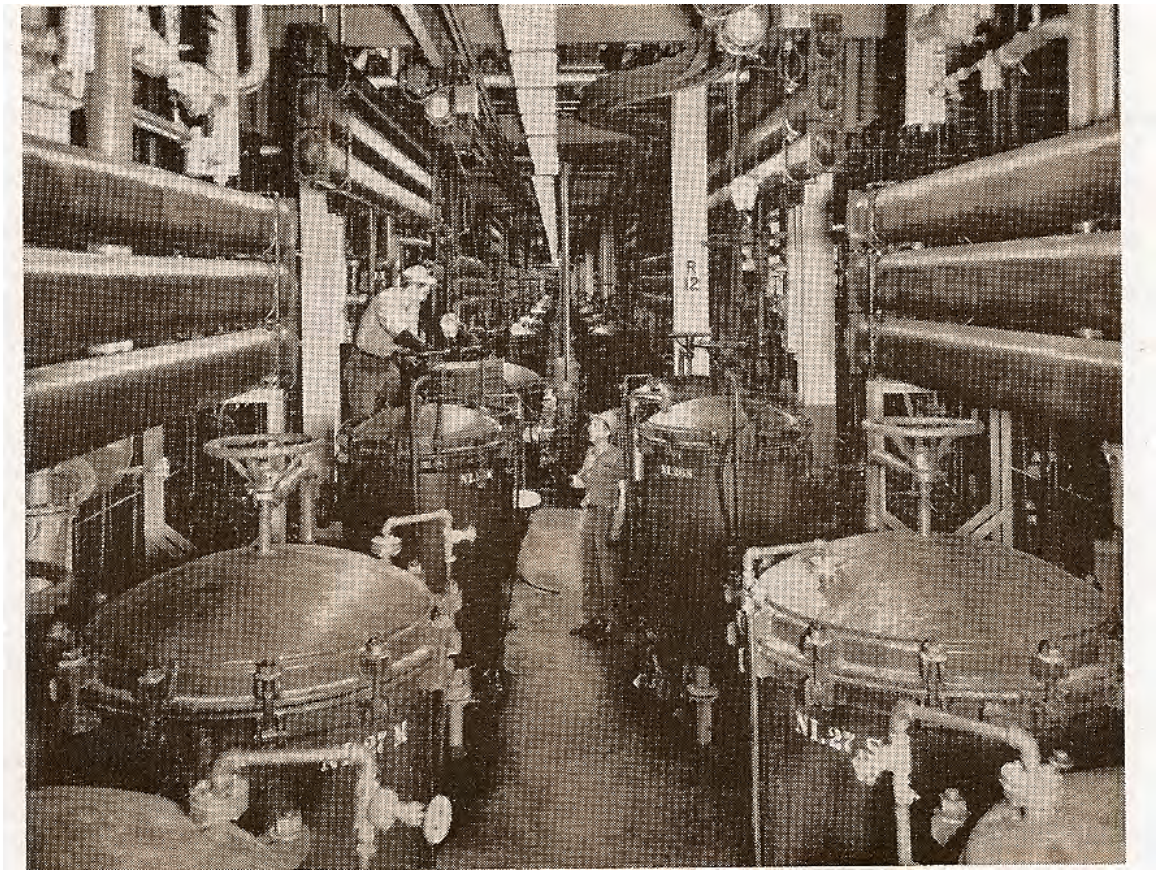
The process of filtration is, basically, the separation of solids from liquids by means of a porous medium that retains the solids and allows the liquid to flow through. A great many variables affect filter selection. Some of these are:

- The amount and compressibility of the solids to be removed.
- Particular process conditions such as pH, temperature and corrosiveness of the solution.
- The volume of slurry to filtered, etc.

A wide variety of filters have been developed to meet these varying process requirements. By far the most widely accepted filter in the chemical industry is the batch pressure filter. This wide usage is due primarily to its great versatility.



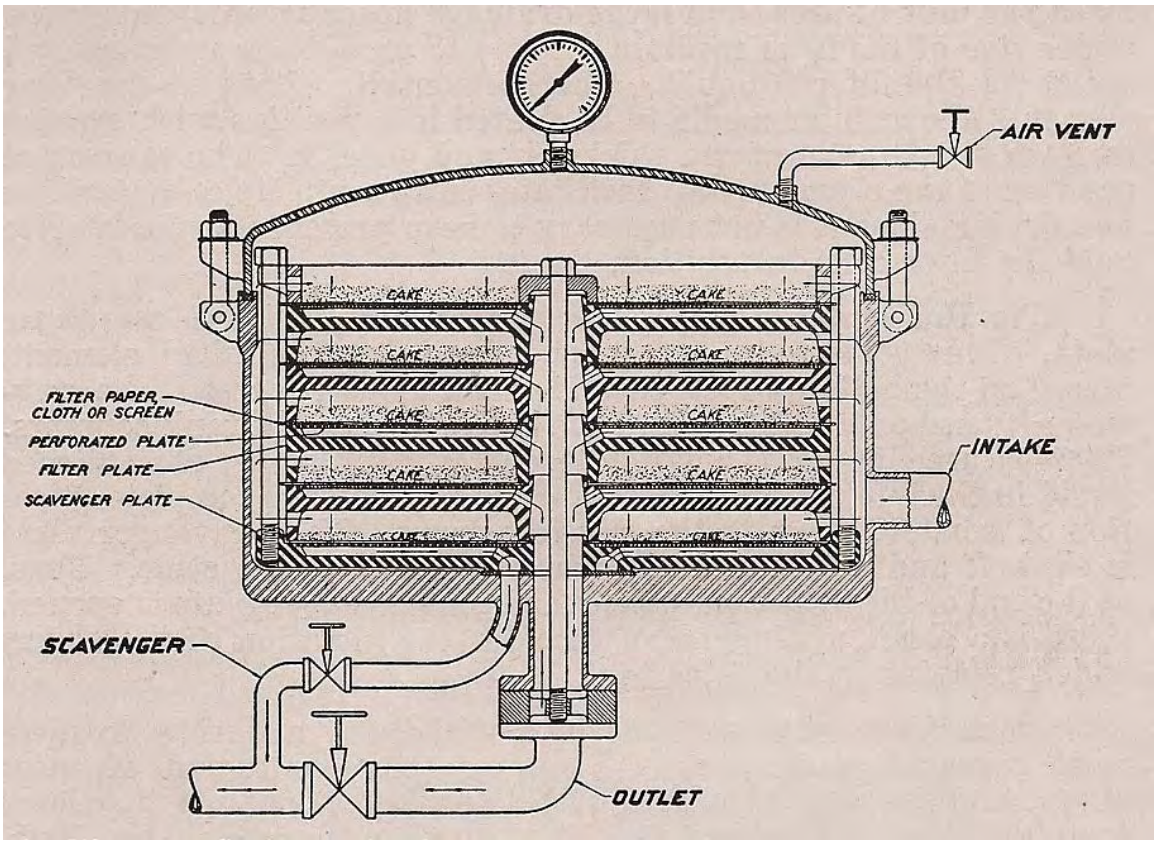
This Article deals with batch pressure filters (Above) that utilize filter elements that are enclosed in a liquid- and vapor-tight tank. This enclosed type of filter offers obvious advantages over the old plate-and-frame press type of batch pressure filter.

The field of batch-type pressure filters can be divided into two main categories. One type is the horizontal-element filter with filtration taking place through the top surface of the element only. This horizontal element uses gravity to hold the filter cake in place when the filter pressure is released in the tank containing the elements.

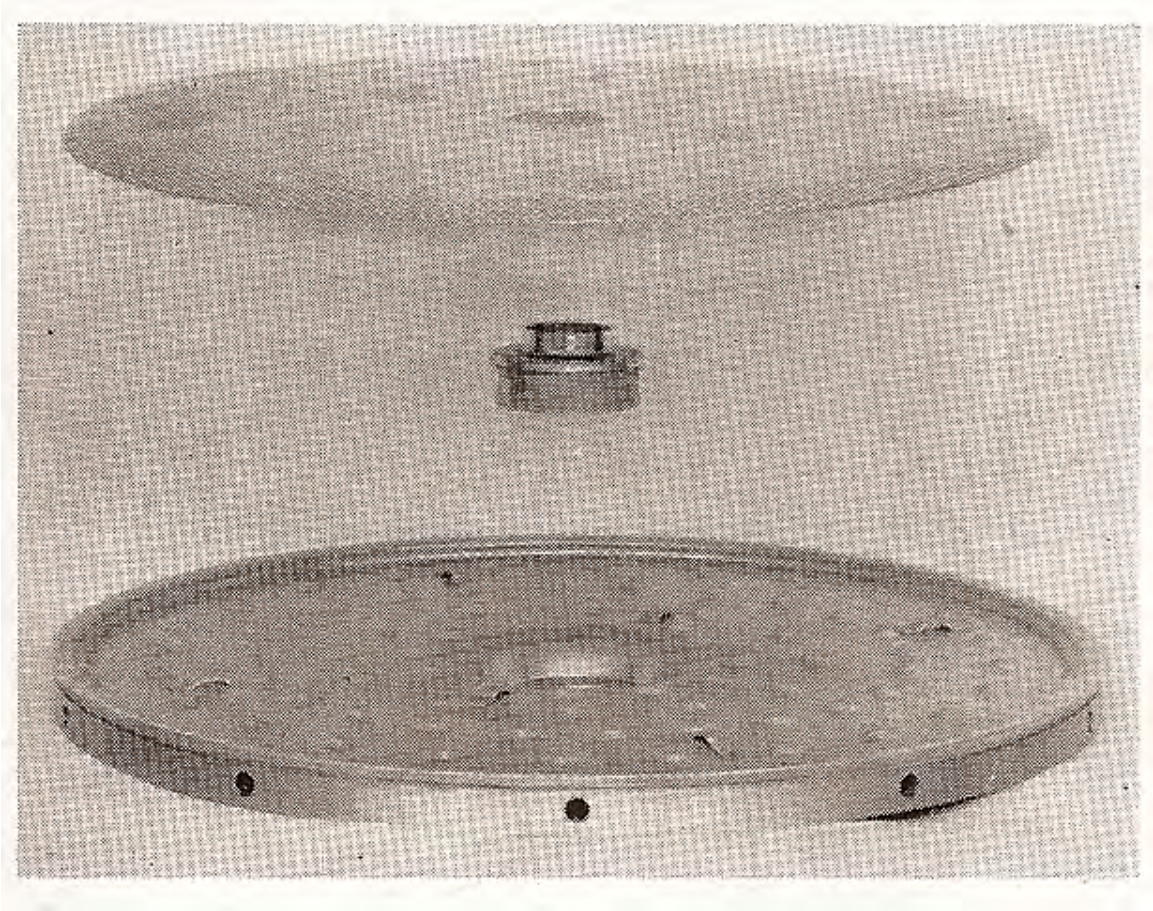
The other type of filter is one that utilizes a vertical element with the slurry flowing perpendicularly to the force of gravity. Filtration takes place through both sides of the filter element. With vertical elements it is easy to discharge the filter cake.

Horizontal Plate Filters

Figure (Below) is a cross sectional view of the Sparkler Horizontal Plate Filter. The Horizontal Plate Filter is ideally suited for applications that require complete control of clarity. Each element is an individual filter; filtration takes place under pressure through all the plates at once. The individual elements are nested into an integral cartridge that is fastened together by means of tie rods, as shown in Figure (Below). This means that the filter elements can be removed from the filter tank as a unit for cleaning. The filter can be provided with a spare cartridge of filter elements, to minimize the down time required for cleaning. Thus, when the spent cartridge is removed, a cleaned cartridge can be immediately placed in the filter tank so that filtration can be continued while the used cartridge is being re-dressed with filter medium.



The Horizontal Plate Filter offers extreme flexibility of operation. Any type of filter medium, such as paper, cloth or wire mesh can be used with maximum efficiency. The medium itself acts as a gasket, sealing each element against the other to insure that no unfiltered liquid can bypass the filtering surface. Each individual plate can be completely disassembled for cleaning, as is shown in Figure (Below). This means that no hidden surfaces are present to cake breakage or slippage, and intermittent operation is possible. The filter can actually be switched on and off without dropping the filter cake or affecting the clarity of the filtrate.

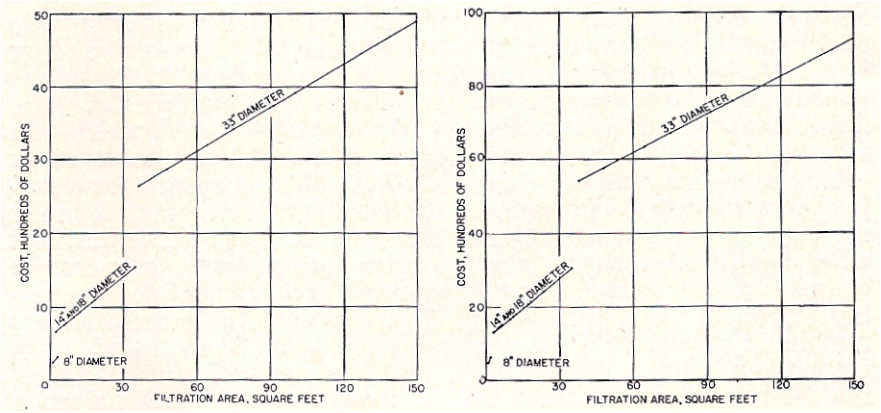


The Horizontal Plate Filter is engineered to provide high flow rates per unit of area, and large drainage space is provided on the under side of the filter medium support to provide an unobstructed outlet for the filtered liquid. The horizontal position of the filter elements allows filter media to be floated into position with gravity to form a cake of uniform thickness and density. The horizontal position of the elements also facilitates more complete cake washing and drying since it is not necessary to keep pressure in the filter to hold the filter cake in position.

The Horizontal Plate Filter can be fitted with a scavenger plate. This consists of an independently valved filter element, placed on the bottom of the cartridge of the filter plates. The scavenger is used only at the end of the batch to filter the tank contents. This feature eliminates any unfiltered heel or hold over of unfiltered liquid in the filter tank.

The scavenger plate allows complete filtration of a batch, down to the last few drops. This scavenger plate is shut off and not used during the regular filtration cycle. Thus, at the end of the filtration cycle, when the scavenger plate is opened, there is a clean, unplugged surface for the filtration of the slurry that remains in the filter tank.

These filters are available in a variety of materials to meet most process requirements. They can be constructed of most alloys, and are also available with lined tanks and plastic plates for highly corrosive solutions. It is possible to construct a Horizontal Plate Filter having no wettable metal parts. Since filtration takes place on a horizontal plane, it is not necessary to use a fibrous precoat material to hold the filter cake on the filter elements, as is necessary with most vertical element filters.



Graphs (Left) give cost of Horizontal Plate Filters with Scavengers, constructed of mild steel and 304 stainless steel, respectively. (For costs in 2010 these prices must be multiplied by a factor of approximately 5.6.)

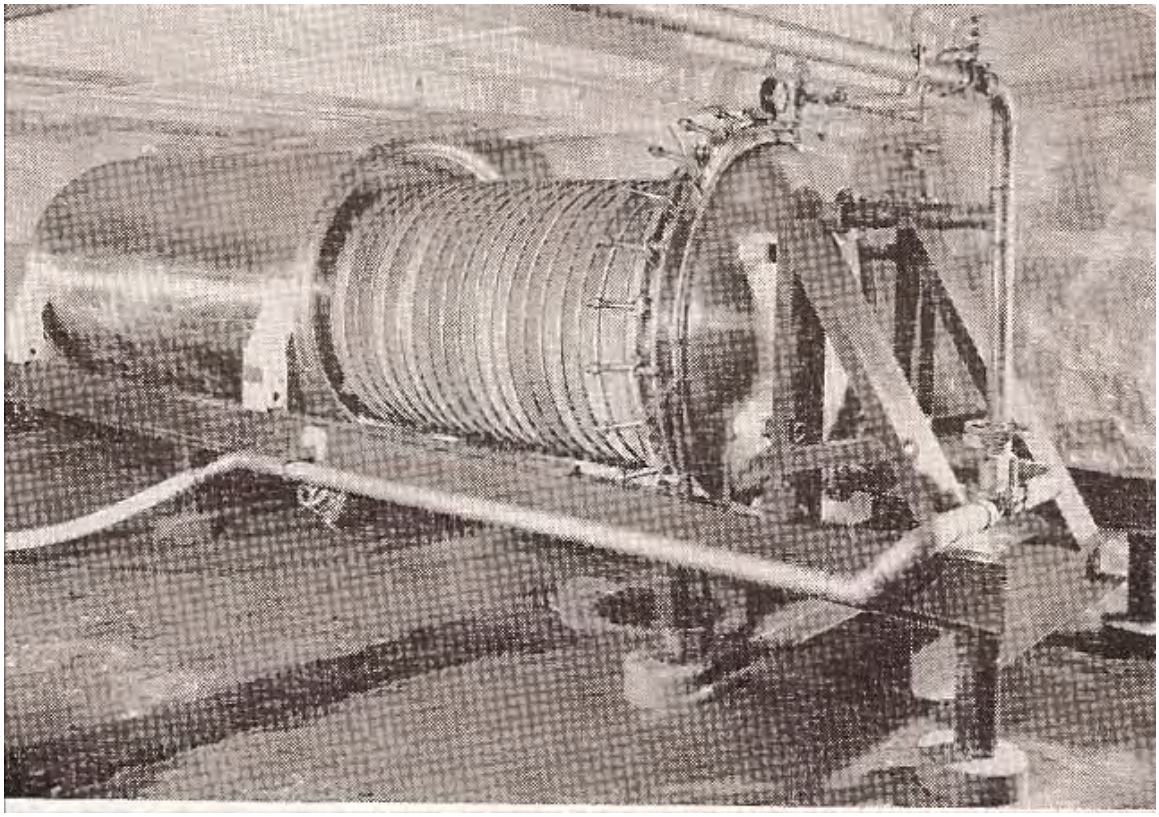
There are many modifications of this basic horizontal plate design. One of these is the Dual Disc Polishing Filter in which filtration takes place through both sides of the horizontal element and the filter medium they support. No filter aid is employed. This filter is designed especially for polishing operations, where only traces ·of solids are to be removed in a final trap, or polish, filtration. Having dual surface plates, it is possible to have twice as much filter area in the same size tank. However, this dual surface plate has very definite limitations, as far as the cake space in the filter is concerned, and, therefore, it is used only as a polishing filter.

Horizontal Plate Filters are available in sizes ranging from 1 to 200 sq. ft. of filtration area in a single unit. Larger units can be constructed for special applications.

Vertical Element Filters

The Vertical Element Filter is designed for rough filtration, where a large percentage of solids is to be removed from a slurry. The vertical position of the filter leaves makes possible easy discharge of the thick filter cakes, which are formed in rough filtration.

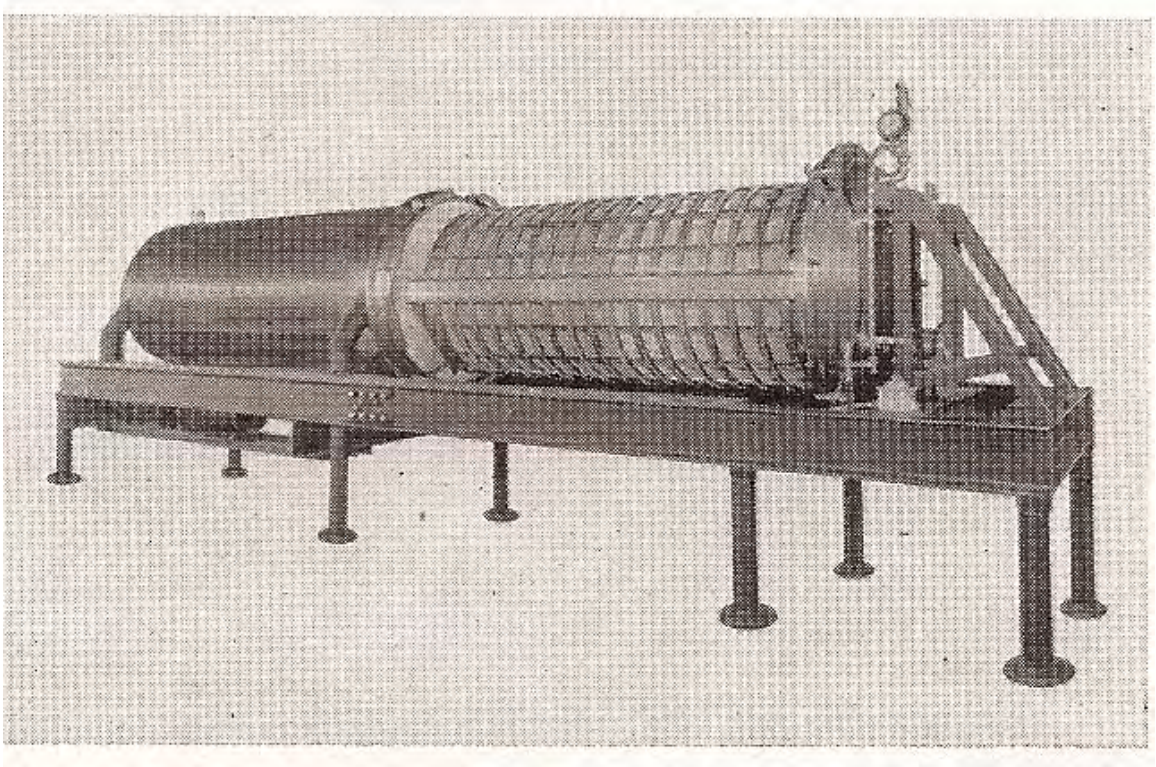
Figure (Below) illustrates: one popular type of vertical element filter. This particular filter has leaves that are actually structural members. These leaves consist of two sheets



of perforated material, welded back to back and separated so that the interior of the plates provides a completely free and unobstructed drainage channel for the filtered liquid. This particular unit is provided with two filtrate outlet tubes, one located at the bottom of the filter leaves, the other located at the top. The advantages of this design are obvious since it provides a more even precoat and better cake uniformity. The filter elements are supported by these outlet tubes, which are fastened to the stationary cover of the filter. All pipe connections are made in this stationary cover, and the filter is opened for cleaning by retracting the filter tank. Thus, it is not necessary to break any pipe connections when the filter is opened. The filter is provided with a quick-opening cover and can be equipped with a hydraulic cylinder, an air cylinder, or a hand-crank arrangement for retracting the filter tank for cleaning. The fact that the filter elements remain in a stationary position while the tank is retracted away from them, rather than having the filter elements moved out of the filter tank, means that the cake does not drop off before a hopper or conveyor is in position to receive the discharged filter cake. The filter elements can be covered with a wire mesh filter medium, or with any type of filter cloth. (This Model has been replaced by the MCRO, which suspends the vessel from a top frame to enable easier access to plates for cleaning and servicing.)

Figure (Below) illustrates the same filter designed to operate with filter paper. In this type of filter the same filter plate construction is provided. However, spacer rings are placed between the elements. These spacer rings and elements are compressed together sealing the filter paper when compression is applied at the end of the frame that supports the filter elements. This unit also has all piping connections in the fixed head, a retractable

tank and double outlet tubes. (This model has also been replaced by the MCRO; instead of filter paper, filter bags are sew over filter plates to enhance longevity.)



Vertical Element Filters, such as shown in photographs (Immediately Above) can be constructed of a variety of materials to meet particular process requirements. They can also be constructed with a lined tank for added corrosion resistance, if necessary. Sizes of these filters range from 100 to 2,000 sq. ft. of filtration area in one unit.

This type of filter has high flow rates per unit area, due to the completely open drainage surface of the interior of the filter elements and the double outlet tubes. Outstanding cake uniformity is a feature of this filter, and the filter has been designed for easy cleaning. It can be completely cleaned and returned to service in a matter of 10-20 minutes, since it is merely necessary to open the quick-opening cover, retract the tank, and drop the cake from the vertical elements into a suitable hopper or conveyor. This is simply done by tapping the edges of the plates. The tank is then closed and locked with the quick-opening cover, and the filter is ready to be put back into operation.

Graph (First Bottom) gives typical cost and filtration area relationships for the Sparkler *Model MCR Vertical Leaf Filter* constructed of 304 stainless steel, having the leaves covered with 30,4 stainless steel 80x80 wire mesh. (Again, these costs must be multiplied by 5.6 to arrive at 2010 approximate costs.)

Another special type of Vertical Element Filter is the completely enclosed self-cleaning filter, which is cleaned without opening the filter tank. The cake is removed from this

type of filter by a stream of water while the cake from the filters shown in Figures 49 and 50 is usually removed in a dry or semi-dry condition.

Photograph (Below) shows a Sparkler *Model SCJ Self-Cleaning Filter*, in which cake removal is effected by means of jet-spray tubes. These spray tubes are adjusted so that the surface of each filter plate is scoured with a high-pressure stream of water.

These filters were designed primarily for use in the water filtration field. However, they are meeting with increasing acceptance in chemical processes where the particular process requirements will permit a vertical element filter with wet cake discharge.

The standard construction of this filter for water filtration is a mild steel tank with sheet rubber lining, and all wettable parts of the filter are either rubber covered or of stainless steel to prevent corrosion. The filter elements are placed individually on the center shaft, which supports the elements and serves as the filtrate outlet.

The filter elements are constructed of two pieces of perforated metal welded together so as to provide a completly open outlet channel for the filtered liquid. Thus, there is no resistance to the flow of the filtrate from the filter. The elements in the standard construction for water are covered with Orlon filter cloth, which precoats quickly and is easily cleaned. The elements, of course, can be covered with any type of filter cloth or wire-mesh filter media. The filter can be used with any type of filter aid such as asbestos, cellulose fiber, diatomaceous earth, etc.

Maintenance on this filter is extremely easy since, when the cover is opened, the filter elements are at shoulder height and can be removed by one man without an overhead hoist or special tools. The sheet rubber lining and the stainless steel parts of the filter make it very durable and long lasting.

Graph (Second Below) gives the typical relationship between cost and filtration area, in sq. ft., for this type of filter. Standard units range from 50 to 400 sq. ft. of filtration area, and units can be built containing up to 2,000 sq. ft. for special orders.

This Self-Cleaning type of filter can be fitted with automatic controls which will automatically clean the filter and re-precoat, etc., and place it back in operation when the pressure reaches a certain pre-determined point, or when the flow drops below a given amount. Since the filter does not have to be opened for cleaning, it is especially well adapted for such automatic controls.

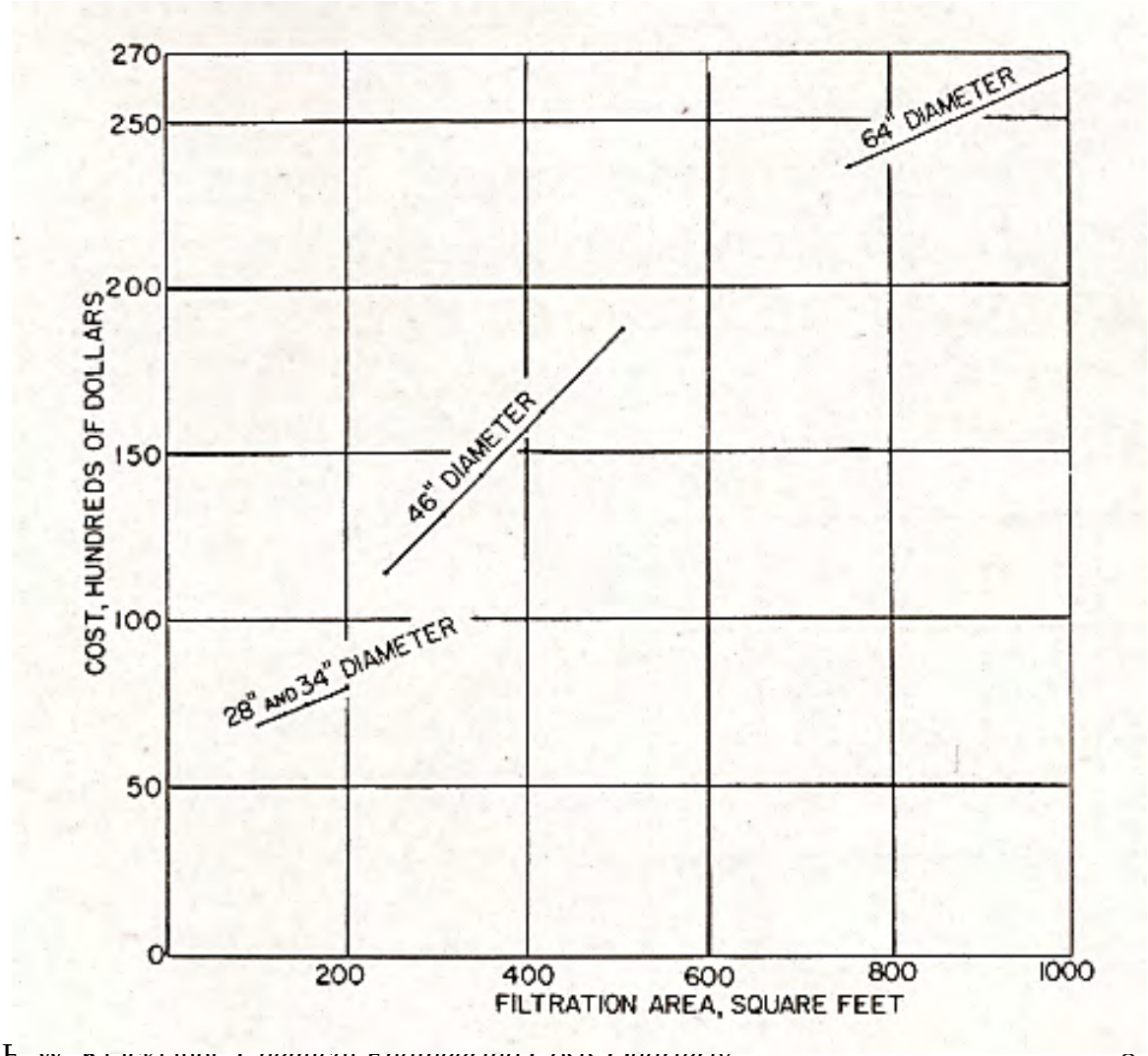
Sizing and Selection

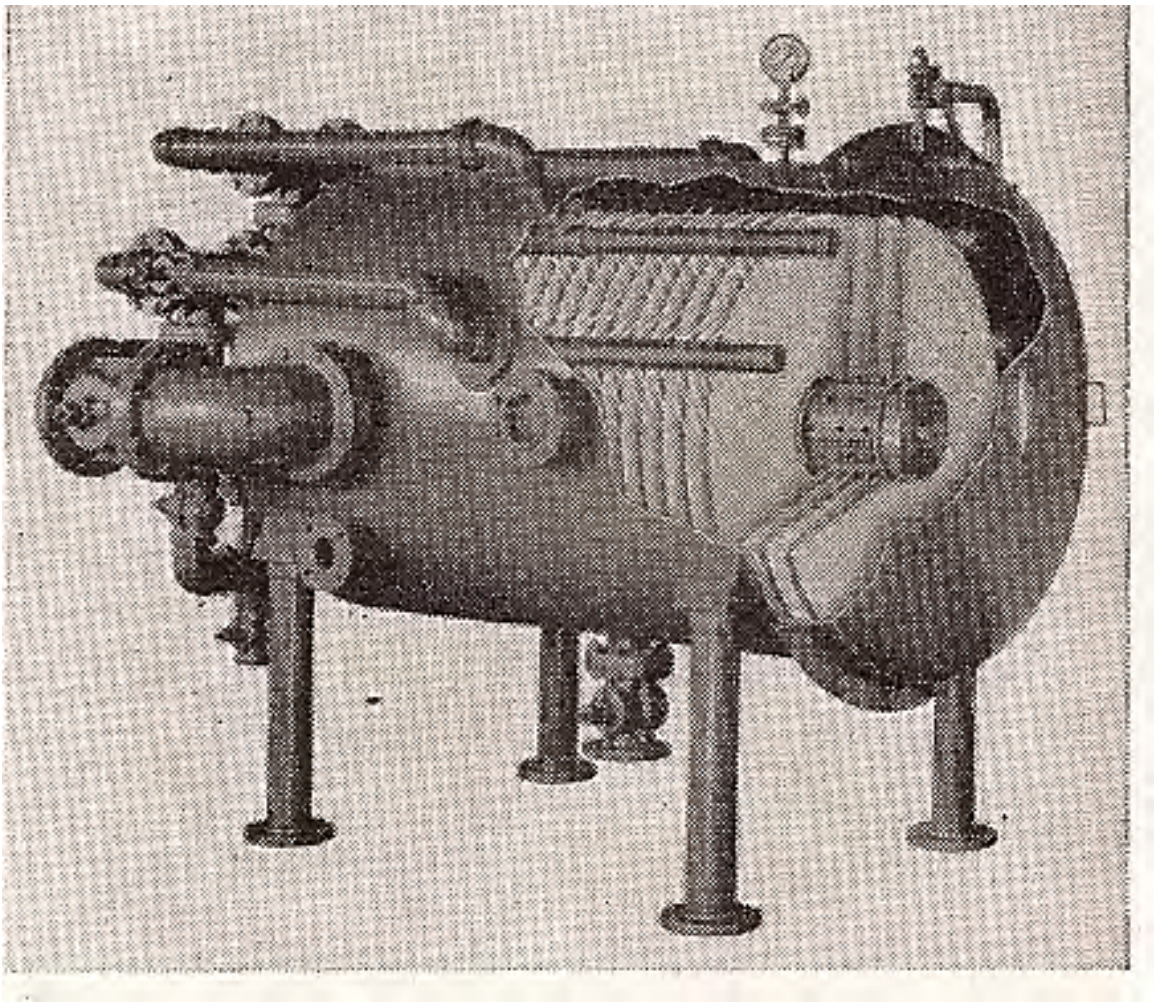
There are so many variables inherent in sizing filtration equipment that it is a recommended procedure for a person intending to purchase a filter to avail himself of the experience of the various filter manufacturers. The best way to size filtration equipment is to actually conduct pilot scale tests on small filters which most filter manufacturers have available. When such tests are not conducted, it is possible to size filters by

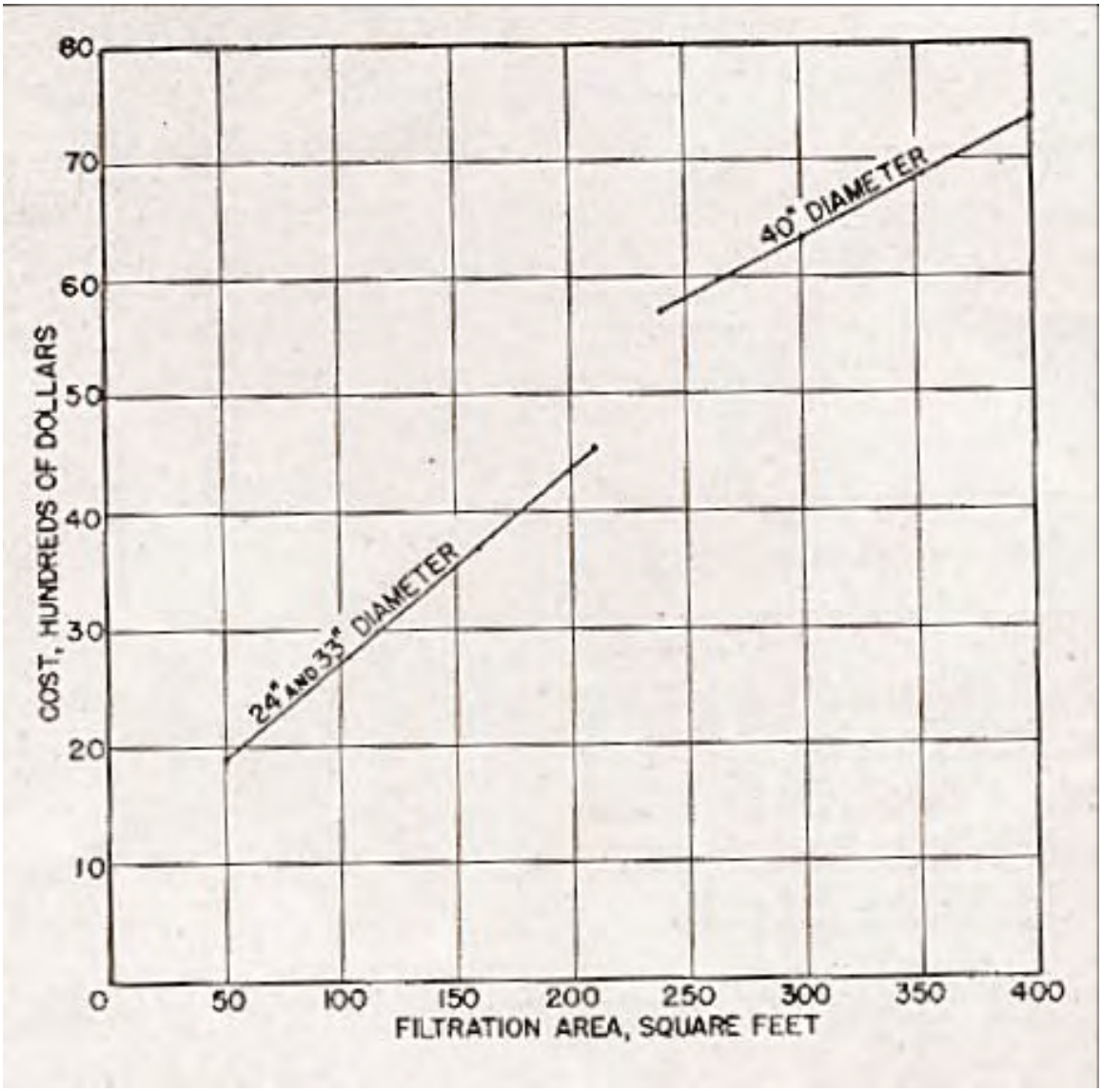
calculation and on previous ,experience. It has been found that when a filter is sized in this way, it is usually necessary to place a considerable safety factor in the calculations, and this usually results in a filter being sized larger than is actually needed. Thus, when filtration data are obtained by actual tests, it is quite often possible to select a smaller sized filter. Where the process conditions permit the use of filter aids, it is usually possible to attain finer filtration, higher flow rates, and longer cycles. The filter manufacturer can also recommend filter aids.

It is often necessary to get expert advice concerning what type of filter to buy, as well as the size necessary. Thus, it can be determined whether a horizontal plate filter, vertical element filter with dry cake discharge, or vertical element filter with wet cake discharge would be better suited to the particular process needs.

The expenditure for filtration equipment often represents a considerable portion of the total capital investment and great care should be given to the selection of the correct type of filter so that the best possible results can be obtained for the least expense over a long period of time. It is important to remember that the smallest original outlay may not be the most economical in the long run.



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COST, HUNDREDS OF DOLLARS
FILTRATION AREA, SQUARE FEET
40" DIAMETER
24" AND 33" DIAMETER