"Angola" Filters for Sugar Filtration[1]

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The Enzinger "Angola" filters are vertical leaf type pressure filters and come as a logical sequence to other Enzinger filters, which have been well-known in the filtration field all over the world since 1890.

Enzinger leaf-type pressure filters are well established in many fields, including oil, beverage, gelatin, food, antibiotics and chemical industries.

The modifications made to the basic Enzinger leaf-type pressure filter in cooperation with men well acquainted with the problems of the sugar industry have produced a filter which is giving superior operating results in sugar plants.

Every plant is confronted with the same problem: that is, to effect the increase of operating efficiency, the decrease of maintenance cost, and the betterment of the final product. The Angola filter permits realization of all of these three items.

In the older type stationary filters, one major disadvantage is common: the comparatively slow and heavy physical work of cleaning the filters. Furthermore, the washing and periodic replacement of filter cloth, a large labor and maintenance item which tends to increase the overall filtration cost, is a disadvantage.

Rotary filters, with their involved mechanisms, require a rather high type of maintenance personnel to keep them in reliable operating condition.

By comparison, in the Angola filter, actual physical work of cleaning the filter consists merely of operating a number of valves. Conventional filter cloth is replaced by practically indestructible metal cloth which does not require frequent replacement. As the entire filter is of stationary design, including the sluicing device, all power-driven mechanisms and their costly maintenance are also eliminated.

In addition, the Angola filter affords:

1. Minimum outage between filtration runs, a factor which becomes particularly important, when due to other difficulties only short filtration runs are obtained and the filters must be cleaned quite frequently.
2. A marked decrease in filteraid consumption per pound of sugar filtered.
3. Elimination of possible contamination from materials of construction, as stainless steel and other highly corrosion-resistant materials are used in the construction of Angola filters.
4. The filter shells lend themselves readily to efficient installation, thus avoiding heat losses and affording better and more rapid filtration.
5. Filtration rates with Angola filters are far greater than with the older type filters and brilliancy of the filtrate shows a decided improvement.
6. Efficient sweetening-off operation represents a decided saving in water and subsequent evaporation and sugar losses.
7. The number of filters previously operated by two men can now readily be operated by one man. Furthermore, the washing of filter

[1] A test report on the filtration of sugar liquors.

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cloths has been eliminated. The Angola filter also eliminates the high maintenance cost encountered on rotary type filters.

Description of Filter

The Angola filter as modified for the sugar industries is a 48 inch diameter leaf-type pressure filter containing 23 leaves spaced on $1^{7/8}$ inch centers, with an effective filtering area of 461 sq. ft. or 547 sq. ft. (depending upon leaf height) and available cake space of 28.9 and 34.2 cu. ft. respectively. The filter tank is designed *in* accordance with A.S.M.E. Code for unfired pressure vessels, Par. U-69. The filter leaves are constructed of stainless steel Type 304 or Type 316. The outer metal cloth is of fine mesh construction. The inner drainage member or backing screen is 4 x 4 x .080 inch wire wesh. The filter leaves are the key to good filtration and require the most careful attention *in* both design and fabrication. The filtrate channel is formed by the frame of each filter leaf and must be maintained free and clear. The screens have to be fabricated so that they will not protrude into this filtrate channel. The supporting tubular frame must be riveted tight under pressure to avoid any by passing of unfiltered liquor between the frames and the outer fine metal cloth. The corners of each leaf are formed to generous radii to permit maximum flow rates and thorough cleaning of each leaf. The three layers of screen are thus fastened together, followed by a rolling operation to insure tightness. No solder is used to effect this tightness between the outer frame and the fine metal cloth.

One of the most important modifications in the Angola sugar filter is the dual inlet connection of two 3-inch connections diametrically opposed. Each of these connections is equipped with a semi-circular channel baffle just inside the filter tank. The purpose of these baffles is to distribute the unfiltered liquor uniformly over all filter leaves, both from the top and from the bottom. With two inlet connections and two baffles, there are actually four unfiltered liquor distributing points. This arrangement permits rapid filling of the filter and thus avoids a decrease in liquor velocity. The turbulence of the liquor entering the filter keeps the filteraid in suspension, resulting in rapid and uniform precoating. Actual precoating time is approximately 5 minutes. This time was established during the last two crops at different sugar cane refineries.

Another modification of this filter is the provision of individual leaf outlets. The filtrate connection from each leaf is piped separately to the outside of the filter tank, terminating in 1 inch valves. From these valves the filtrate discharges into a common cooling trough. Samples may be taken from each individual outlet and tested for clarity and brilliancy. If for any reason the clarity of the filtrate is not satisfactory, this arrangement permits taking that leaf out of service. Also, when sweetening-off the filter, the flow of sweet water may be throttled in order to keep the amount of sweet water used to a minimum. This arrangement permits better control of the filter, especially when sugar liquors pretreated with vegetable carbon are to be filtered.

The entire filter is usually insulated with a 2 inch thick glass wool blanket to conserve the heat of the sugar liquor as much as possible. The filter tank cover is arranged with a mechanical toggle lifting device and the cover swings on anti-friction bearings so that, after opening the clamp bolts around the periphery of the cover, the latter may be swung out of the way with a minimum of effort.

The stationary sluicing device is mounted in the top cover. This unit consists of a pipe header and a series of strategically located spray nozzles, arranged in such a way that the fan sprays of these nozzles not only form an uninterrupted spray pattern but also cover both sides of all filter leaves simultaneously. This system is designed to operate on 60 psi water pressure.

In addition to the top sluicing device, the Angola filter is equipped with two additional, but smaller, headers mounted in the tank bottom underneath the filter leaves. Each header is equipped with small nozzles pointing upwards into the spaces between the filter leaves. Both of these headers are connected to low pressure steam. In addition to supplementing the effect of the sluicing header, the steam headers may also be used for preheating the filter before filtration. The sluicing device is highly effective. Long range field tests showed that during one entire crop the average sluicing time per cycle was approximately 5 minutes.

The discharge of the spent cake is effected through a 6 inch valve at the bottom of the filter.

The inside of the carbon steel filter tank is coated with a baked on phenolic resin coating. Since all leaves are of stainless steel, there is only one metal in contact with the sugar liquor, and because of this no galvanic action can be expected, even with vegetable carbon for decolorization. Therefore, this coating prevents any possible corrosion of filter screens.

The precoating is generally made up with filtered liquor and about .14 lbs. of filteraid per each sq. ft. of filtering area. The size of the precoat tank should be approximately 100 gallons larger than the capacity of the filter tank and should be equipped with mechanical agitator rather than air agitator.

The filter is equipped with an overflow connection so that any accumulated air in the top of the filter tank may be bled off, thus insuring a completely filled tank at all times.

History

The first Angola filter for the sugar industry was designed and built in 1949 and installed for trial early December of the same year in the cane sugar refinery of the Fellsmere Sugar Producers Association, Fellsmere, Florida. The capacity of this refinery at that time was approximately 1,500 to 2,000 bags of 100 lbs. each of granulated sugar per 24 hours. One filter of 461 sq. ft. effective filtering area was sufficient for the filtration of all affined and treated sugar melt at 60° Brix. Since that time the Fellsmere plant increased its refining capacity and subsequently bought another Angola filter for the present crop. These filters were also installed during the past two years in refineries in Puerto Rico, Cuba, Venezuela and in the continental United States.

There are no Angola filters installed as yet in any beet sugar factories, but it is believed that this type of filter will be equally efficient and economical in operation for the filtration of second carbonation juices or standard liquors in beet sugar factories as it has proved to be in cane sugar factories.

First Test Run at the Fellsmere Refinery

This factory used Sucre Blanc and vegetable carbon process. The first Angola filter was installed as shown in Figure 1, piping diagram. An existing plate and frame press was used as "check filter."

Sugar liquor was available in batches of 1,000 gallons each, and since the filter was capable of filtering this liquor at a much higher flow rate than the unfiltered liquor could be furnished during the first test, it was necessary to recirculate the filtered liquor between batches. Eventually, the individual leaf outlet cocks were adjusted so that the flow rate of the filter timed with the availability of the unfiltered liquor, and in that way the recirculating time was either eliminated completely or cut to a minimum.

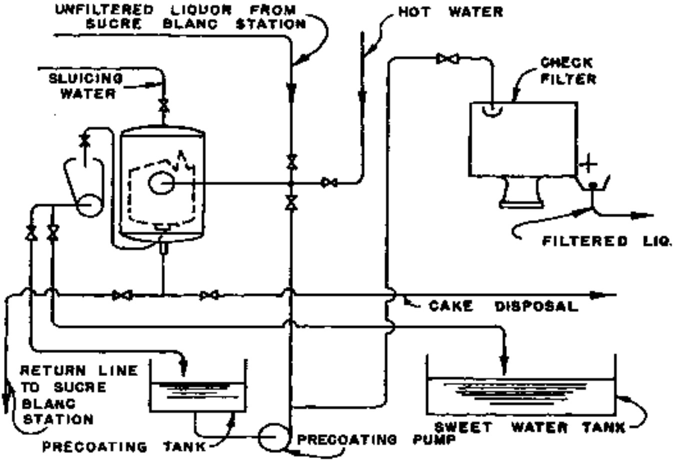

Figure 1.

During these tests the following data were recorded:

1. Number of 1,000 gallon tanks.
2. Time elapsed per tank.
3. Filter Pressure.
4. Strike (Type of raw sugar A or B) .
5. Amount of filter-aid used.

The Brix ratings of the liquors were determined, and furnished by the plant chemist. All of these data were tabulated and plotted.

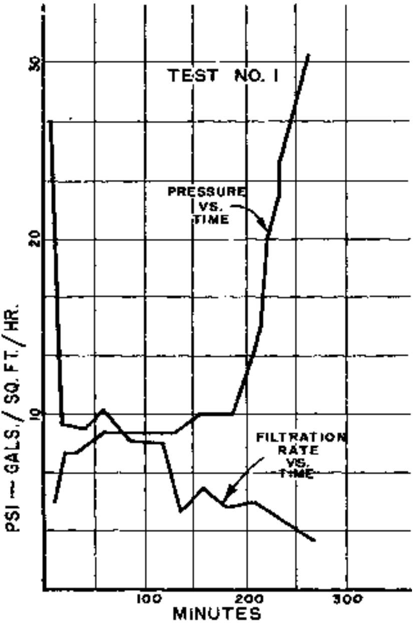

Figure 2.

Test No. 1.

For the initial filtration test the filter tank was filled from the precoating tank on the floor below. One hundred pounds of filter-aid was slurried up in the precoating sugar liquor tank by means of air agitation. This slurry was pumped through the filter with all valves open wide. The filtrate started to show clear after less than 5 minutes of precoating and filtration was started.

The first 1,000 gallons of sugar liquor were filtered in 5 minutes. The outlet cocks of the individual leaf outlets at that time were all wide open. The second batch, however, was not available until 10 minutes later, and *in* the interim the filtrated liquor was recirculated to maintain pressure on the filter leaves. A total of 14,000 gallons was pumped through this filter, and it is to be noted that the pressure on the filter increased sharply after batch 12. This was due to a disturbance in the clarification operation ahead of the sucre blanc station. This caused a far greater amount of mud of slimy calcium phosphate precipitation to come through with the unfiltered liquor than in normal operation.

Sweetening-off.—During the first test sweetening-off was not successful, due to operating difficulties outside of the filter.

Sluicing.—Steam was applied through the two steam headers in order to break up part of the spent filter cake, since the filter had been opened and a good part of the moisture from the spent filter cake had evaporated.

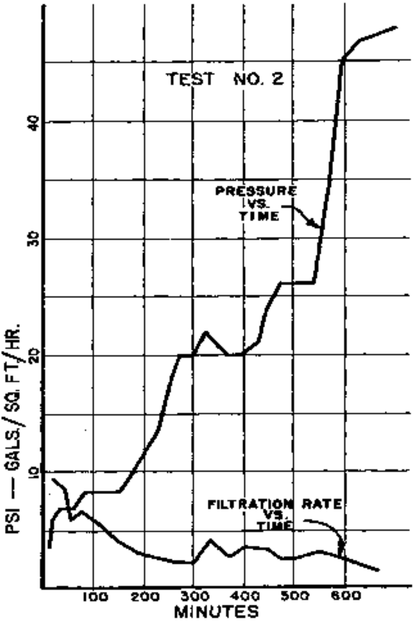

Figure 3.

The steam was kept on the filter for about 5 minutes, and caused the greater part of the filter cake to slough off. Then the sluicing-water pump was started and full pressure and volume of the sluicing pump applied to the sluicing device. Inspection showed no trace of filter-aid on any part of the filter.

The following are the results of **Test No. 1:**

A total of 14,000 gallons was filtered in 258.5 minutes; deducting 450 gallons of liquor, which was returned to the sucre blanc station at the end of this filtration run, a total of 13,550 gallons of sugar liquor, at an average Brix rating of 57°, was filtered; or an average flow rate of 52.4 GPM through the filter was obtained, which is equivalent to 6.68 gals./sq. ft./hr.

One hundred pounds of precoating and 115 pounds as subsequent additions to the unfiltered liquor, resulting in a filter-aid consumption of .00262 pounds of filter-aid per pound of sugar solids melted. On basis of syrup, the consumption was .0158 pounds of filter-aid per gallon of syrup. The graph of Test No. 1 shows clearly the rather slow increase of filtration pressure until the before-mentioned disturbance in the clarification operation took place, and at which time the pressure started to build up very rapidly.

The filtration rate curve showed a gradual decrease from the initial tremendous flow of somewhat over 25 gals./sq. ft./hr. to a final flow of 2.68 gals./sq. ft./hr., or an average flow rate of 6.68 gallons per sq. **ft./hr.**

Test No. 2.

During the second test run the filter was again precoated and showed clear filtrate after 5 minutes of operation. During this second test **run** an effort was made to increase the filter pressure in only very small increments, and as a result it was possible to filter a total of 20,000 gallons. It would have been feasible to filter an additional amount, but the test had to terminate because of a scheduled refinery shut-down. Runs as high as 32,000 gallons on one precoat have since been made, with satisfactory flow rates.

Sweetening-off.—After the completion of the filtration cycle, the filter cake was sweetened-off by turning the hot water into the filter inlet in such a way as to maintain the same pressure as existed during the final phase of the test run. The discharge from the filter was permitted to run into the filtered liquor tank, and the Baume' rating of the liquor during the sweetening-off cycle was checked continuously until a rating of approximately 20° Be' was obtained.

After the filtrate was brought down to 20° Be', it was turned into the sweet water tank and all of the individual discharge cocks were throttled as far as possible in order to keep the amount of sweet water used to a minimum. It was also found that the time of contact of the sweetening-off water with the filter cake is far more influential than a high rate of flow. A leeching effect of the hot water is desirable, in order to obtain thorough sweetening-off of the filter cake. A total of 660 gallons of sweet water was used, or the equivalent 1.47 of the volume of the filter.

It is to be noted that, with the exception of the sudden increase in the last two batches, the filter pressure increased slowly, in comparatively even increments. The filtration rate (apparently as a direct result of slow increase in filtration pressure during the run) diminishes very slowly and showed an overall average of 3.87 gals./sq. ft./hr. or a flow rate through the filter of 30.3 GPM.

It is to be seen that the decrease in filtration rate over that shown in Test No. 1 is directly due to the effort of keeping the filter operating at the rate at which the batches of unfiltered liquor became available.

During the second test a total of 300 pounds of filter-aid was used, which is equivalent to .00252 pounds of filter-aid per pound of sugar solids melted, or .0154 pounds of filter-aid per gallon of liquor.

As during the first test the filter was again opened prior to sluicing off the cake, and samples of this cake were taken. Of course, it is obvious that by the time the filter was closed again a good part of the moisture had evaporated and caused the cake to be rather dry and sticky. Inspection showed that a cake thickness of approximately 3/8 inch had deposited. A precoating of approximately 1/16 inch thick was quite noticeable. Samples of this cake showed a .604 polarization, which is equivalent to a negligible amount of sugar left in the spent cake. The filter was again closed and steam turned on. The greater part of the cake sloughed off immediately and after approximately 5 minutes the sluicing water was turned on; the filter was found to be absolutely clean after 6 minutes of water sluicing.

These tests and other field checks have proved that the Diatomite filter is entirely practical for the sugar industry.

Summary

All filters do not require the individual leaf control cocks, and such filters are equipped with a common manifold outlet for all leaves; these filters are identical in all other respects to the one described earlier. The filter leaves for either filter with or without individual cocks are of the same design and construction.

The automatic sluicing, which is essential when continuous operation is involved, can be done away with for batch operation. In this case, the filter is equipped with a chain-type hold-down bar. Removing this bar allows the filter leaves to tilt toward the fixed center leaf, thus exposing a large surface of the leaf for convenient manual sluicing of the spent filter cake, without removing the leaves from the filter. The tilting of the leaves does not cause the leaf outlet nozzles to disengage from their seats in the outlet manifold. The fact that the leaves do not have to be removed from the filter prolongs their life, as they are thus not subjected to mechanical damage.