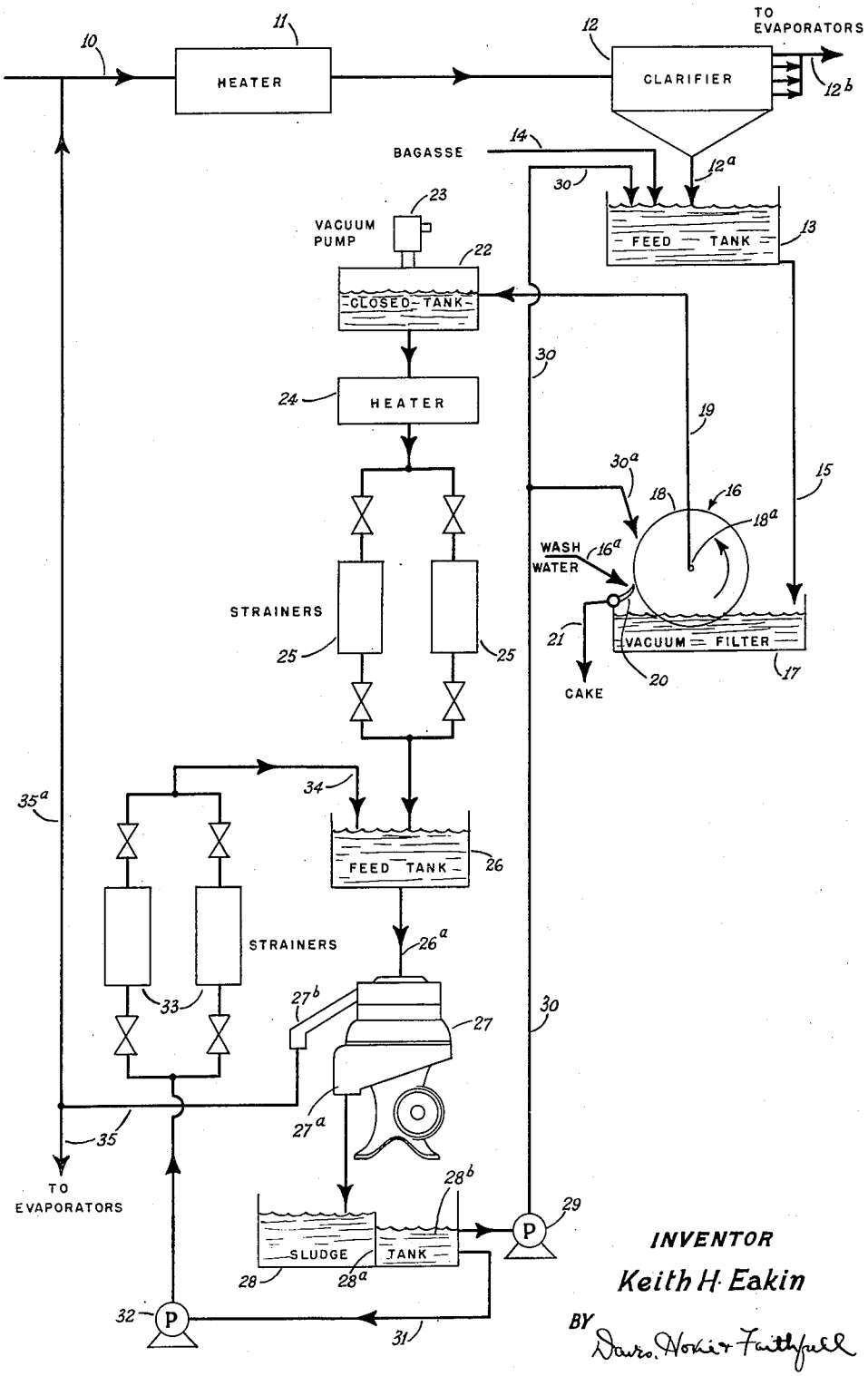
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CLARIFICATION OF SUGAR CANE JUICE

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CLARIFICATION OF SUGAR CANE JUICE

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The invention relates to the clarification of sugar cane juice and has particular reference to an improved method and system for this purpose.

The processing of cane sugar usually involves five stages, namely (1) crushing of the cane and extraction of the juice, (2) defecation of the juice, (3) clarification of the juice, (4) concentration of the clarified juice by evaporation, and (5) crystallization of the sugar. In the first stage, the harvested cane is shredded and crushed by passage through the mill system, which may consist of several heavy crushing rolls preceded by the cane cutters and shredders. As the cane passes through the rolls, it is crushed so that the raw sugar juices are squeezed from it and drain through the bottom of each mill stand. Passing counter-currently to the crushed cane, water is fed to the last mill and finally emerges from the first mill as the crude juice. The crushed and extracted cane leaving the last mill is known as "bagasse," which is used as fuel or for the manufacture of by-products.

The second stage, or defecation, is a clarification process similar to that used in the beet sugar industry, in which milk of lime is added to the juice to precipitate insoluble impurities and at the same time to carry down a considerable amount of insoluble sediment in the subsequent clarification. The liming is generally performed in large batch tanks which supply the juice to a continuous gravity settler or clarifier. In some cases, the defecation stage also involves treatment of the juice with sulfur dioxide gas.

In the third or clarification stage, the limed juice is heated to a temperature of 212°–220° F. before it is fed to the gravity settler. The flow of the juice to the settler is maintained at such a rate that most of the suspended heavy solids are able to settle to the bottom of the settling tank as a mud, which is continually removed by slowly revolving rakes or plows. The gravity settler may be of any desired type, such as a Dorr clarifier. The clarified juice, which usually represents 85%–90% of the volume of the crude juice, overflows into a launder or tray at the upper part of the settling tank and passes to the evaporators for concentration. The sediment or mud, which is removed continuously from the bottom of the settling tank, usually constitutes 10%–15% of the crude juice volume and contains the lime salts precipitated from the crude juice by the liming operation, a considerable excess of lime, shredded fiber from the cane, and a considerable quantity of dirt and sand washed

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from the cane in the mills. The total sediment in this mud is generally about 20% insoluble material. The fluid portion of the mud, approximately 80%, contains considerable amounts of sugar in solution, and in the interest of economy it is necessary to reclaim as much of this sugar as possible.

Heretofore, it has been common practice to reclaim sugar from the mud in the gravity settler by feeding the mud to a vacuum filter, after adding to the mud a considerable amount of bagasse to act as a filter aid. The vacuum filter, which may be an Oliver filter, serves to remove the sediment as a cake, which is subsequently washed to reclaim the soluble sugar. The filter consists of a large hollow drum rotating slowly on a horizontal axis with the lower portion of the drum immersed in the feed liquid or mud from the clarifier. A partial vacuum is maintained on the submerged outer surfaces of the drum so as to suck relatively clear juice into the drum through the metal screen which forms its periphery. A cake of solids is thus built up on the drum, and as the drum rotates the cake moves above the level of the feed liquid to a point in the cycle of the drum rotation where it is continually washed with a spray of fresh water. Then, at a subsequent point in the cycle, a doctor blade adjacent the surface of the drum scrapes off the cake, after which the cleaned drum surface again moves down into the feed liquid to complete the cycle.

Since the smallest opening which is practical in the periphery of the filter drum is seldom less than 0.20", the filtrate from the vacuum filter, even when considerable amounts of bagasse are used as a filter aid, generally contains from 2%–12% total suspended solids. One of the factors which prevents cleaner filtration is probably the cane wax present in the mud, which would act to seal completely the finer filter clothes which would be needed on the drum to clarify the filtrate more effectively. Because the filtrate, in any practical operation of the vacuum filter, contains a substantial quantity of mud, it is not possible to feed the filtrate directly into the evaporating stage. Consequently, it has generally been necessary to recycle the filtrate from the vacuum filter to the Door clarifier or other gravity settling tank. This has been true under ordinary operating conditions, but, especially when the cane is harvested during wet weather, the amount of dirt in the raw cane may be so great that the filtrate from the vacuum filter may contain as much as 12% suspended

solids. To return such a filtrate to the gravity settling tank or clarifier would overload the latter, with the result that the production line would soon have to be shut down. Accordingly, it is sometimes necessary to discard the filtrate, which means a loss of valuable sugar.

The present invention has for its principal object the provision of an improved process and system for recovering sugar from the mud in the gravity settler or clarifier, which overcomes the above-noted disadvantages in the prior treatment of this mud.

According to the invention, the sugar cane mud from the clarifier or gravity settling tank is delivered to a filter, preferably a vacuum filter of the Oliver type, where a portion of the sediment is removed as a filter cake from the liquid component of the mud. This liquid component or filtrate, with the remaining mud, is then fed through a heater where it is heated to a temperature of at least 180° F. The heated filtrate, after being strained to remove the larger particles, is fed to a centrifugal separator of the type in which the centrifugal bowl or locus of centrifugal force is provided at its outer periphery with outlets for discharging a sludge component. In the bowl, the filtrate is centrifugally separated into a clarified juice component and a sludge component, the latter being discharged through the peripheral outlets, and the clarified juice being discharged through a separate outlet. At least part of the sludge component discharged from the centrifuge is recycled to the filtering operation for further recovery of sugar from the sludge. Preferably, the sludge component from the centrifuge is passed through a gravity settling tank for removal of the heavier and more erosive particles before recycling of the sludge. The recycled sludge may be delivered to the filtering operation by mixing the sludge with the mud fed from the clarifier to the filter, or by spraying the sludge upon the filter cake. The latter may then be subjected to a washing operation, along with the recycled sludge, to remove the dissolved sugar.

I have found that when the mud from the clarifier is treated in this manner the effluent or clarified juice component from the centrifuge will contain as little as 0.3%–0.6% solids. At the lower solids content, which is possible under more favorable conditions with respect to the amount of dirt and sand in the raw cane, the effluent or clarified juice component from the centrifuge is clean enough to be fed directly to the evaporator, thereby eliminating the necessity of recycling the juice to the clarifier. Thus, the process produces a fresher juice, simplifies the operation, and reduces operating costs. At the higher solids content, 0.4%–0.6%, the effluent from the centrifuge may be recycled to the gravity settler. However, since the solids content is relatively low even in this case, the recycled filtrate does not overload the clarifier, and so it is not necessary to incur the loss of filtrate which would result from the prior practices, especially during periods of wet weather.

By recycling part of the sludge component from the centrifuge to the inlet line of the centrifuge, it is possible to regulate the concentration of the sludge component, which may contain up to 35% solids.

For a better understanding of the invention, reference may be had to the accompanying drawing in which the single illustration is a schematic view of a preferred system for practicing the invention.

Referring to the drawing, the limed sugar juice from the defecating operation is delivered through a pipe 10 to a heater 11, where it is heated to a temperature of about 212°–220° F. From the heater 11, the juice is fed continuously to a gravity settler or clarifier 12, which is preferably of the Dorr type, having revolving rakes or plows (not shown) for continuously discharging the settled mud through a bottom outlet 12*a*. The clarified juice, approximately 85%–90% of the crude juice volume, is discharged from the upper portion of the clarifier 12 through launders or trays to an outlet 12*b*, from which the clarified juice is delivered to the usual evaporators. The mud which settles to the bottom of the clarifier 12 is discharged through outlet 12*a* to a feed tank 13, where the mud is mixed with a considerable amount of fine bagasse fed from a pipe 14, the bagasse acting as a filter aid in the subsequent filtering operation.

The mud is fed continuously from tank 13 through a pipe 15 to a vacuum filter 16, which is preferably of the Oliver type. The filter comprises a container 17 for receiving the mud, and a hollow drum 18 rotatable on a horizontal axis 18*a*. The periphery of the drum is formed by a metal screen so that the drum is perforated, and the drum rotates slowly with its lower portion immersed in the mud in container 17. The interior of the drum is connected at the axis 18*a* to a suction line 19, whereby a partial vacuum is maintained on the submerged outer surfaces of the drum so as to suck relatively clear juice from container 17 through the perforated periphery of the drum and into the vacuum line 19. Consequently, a cake of solids accumulates on the outer surface of the drum. As the drum rotates, this cake is moved above the level of the mud in the container 17 and carried around to a doctor blade 20 pressing against the drum surface, so that the cake is scraped off the drum and discharged from the filter as shown at 21. The cleaned drum surface then rolls down into the mud in the container 17, and the cycle is repeated. Prior to the scraping operation by the blade 20, the filter cake is preferably washed with a spray of fresh water delivered through a pipe 16*a*.

The filtrate from the filter 16 is sucked through the pipe line 19 to a closed tank 22 which is maintained under a partial vacuum by a vacuum pump 23. The filtrate passes from the tank 22 through a heater 24 where it is heated to a temperature of at least 180° F. The heated filtrate is then passed through twin strainers 25 to remove the larger particles from the filtrate, and from the strainers 25 the filtrate is delivered to a feed tank 26. The latter is connected through a pipe 26*a* to the inlet of a centrifuge 27 having a sludge outlet 27*a* and a clarified juice outlet 27*b*. The centrifuge 27 is preferably of the De Laval AC–VO type, in which the centrifuge bowl is provided with peripheral outlets for the sludge and a separate outlet located nearer the bowl axis, for discharging the clarified juice.

The separated sludge component discharged from the centrifuge outlet 27*a* is delivered to a sludge collecting tank 28. The tank 28 functions as a feed tank for pumps 29 and 32 in pipe lines 30 and 31, respectively, and is preferably fitted with a vertical partition 28*a*. In the tank 28, the heavier and more erosive particles of the sludge settle out, the lighter particles passing over the partition 28*a* to a sub-compartment 28*b* of the tank. At least part of the discharged sludge component is fed continuously from the com-

partment 28b by a centrifugal pump 29 to a pipe line 30, through which the sludge component is recycled to the filtering operation, as by returning the sludge to the feed tank 13. Alternatively, the recycling of the sludge component may be effected by feeding it from pipe 30 through a branch pipe 30a which sprays it upon the filter cake on the drum 18.

Part of the discharged sludge component from the centrifuge is preferably fed from the sludge collecting tank 28 through a pipe 31 to a centrifugal pump 32 which feeds the sludge through twin filters 33 and pipe 34 to the centrifuge feed tank 26. In this way, it is possible to increase the concentration of the sludge component discharged from the centrifuge outlet 27a, and by regulating the rate of recycling to the feed tank 26, the concentration of the sludge may be adjusted.

The effluent or clarified juice separated in the centrifuge 27 is discharged through outlet 27b to a pipe 35. From the latter, the clarified juice component may be fed to the evaporators. However, in cases where the mud from the clarifier 12 contains excessive quantities of sand and dirt, I prefer to recycle the sludge component directly from the centrifuge outlet 27b through pipes 35 and 35a to the clarifier 12.

The practice of the present invention enables a practically complete recovery of sugar from the mud in the clarifier or gravity-settling zone 12, and yet the added load, if any, on the gravity-settling zone 12 is inconsequential, even under the most adverse conditions with respect to the amount of sand and dirt in the raw cane. Sludge from the centrifuge 27 is subjected to a further sugar-recovery operation as a result of its recirculation to the filter 16, either by being mixed directly with the feed to the filter receptacle 17 or by being delivered directly to the filter cake. The sludge combined with the filter cake which is discharged at 21 may be further processed for recovery of remaining sugar. Since it is not necessary to effect a fine filtering of the material at the filter 16, the latter may be operated at relatively high capacity so as to handle the increased load represented by the sludge recycled to the filter feed tank 13.

I have found that the heating of the filtrate prior to its introduction into the centrifuge 27 is an important factor contributing to the successful operation of the new process and system. Preferably, the filtrate is heated in the heater 24 to a temperature of 200° F. or higher. Unless the filtrate is heated to a temperature of at least 180° F. prior to the centrifuging, the centrifugal bowl will become clogged or plugged after a relatively short period of operation, with the result that the recovery of sugar is impaired. This is evidently due to the presence of wax in the filtrate, and by centrifuging the filtrate at a temperature of about 200° F. or more, which is somewhat above the melting point of the wax, the centrifugal separation is greatly facilitated.

It will be apparent that the sludge settling tank 28, pump 29 and pipe 30 constitute a means for recycling at least part of the sludge component from centrifuge 27 to the filtering operation at filter 16, by way of either the feed tank 13 or the branch pipe 30a, or both. In the sludge tank 28, the heavier and larger particles are removed from the sludge, so that the system recycles to the centrifuge only the smaller particles of sludge, which have less of an erosive action on the centrifugal bowl and do not clog the outlets for the sludge.

I claim:

1. In the clarification of sugar cane juice containing suspended heavy solids, by feeding the juice to a gravity-settling zone where the solids settle to the bottom as a mud, separately discharging the clarified juice and the mud from the upper and lower regions, respectively, of said zone, and subjecting the mud from said zone to a filtering operation to recover juice therefrom as a filtrate, leaving a filter cake of mud, the improvement which comprises straining said filtrate, feeding the strained filtrate at a temperature of at least 180° F. to a locus of centrifugal force and there separating it centrifugally into a clarified juice component and a sludge component, separately discharging said components from said locus, and recycling at least part of the sludge component from said locus to the filtering operation to recover sugar from the sludge.

2. The improvement according to claim 1, comprising also the step of feeding said sludge component through a gravity-settling zone before it is recycled to the filtering operation.

3. The improvement according to claim 1, in which said sludge component is recycled to the filtering operation by spraying the sludge component on said filter cake.

4. The improvement according to claim 1, in which said sludge component is recycled to the filtering operation by spraying the sludge component on said filter cake, the improvement comprising also the step of washing the filter cake together with said sludge component to recover the soluble sugar therein.

5. The improvement according to claim 1, comprising also the step of feeding part of the sludge component to the centrifugal locus along with said strained filtrate, to increase the concentration of said sludge component.

6. The improvement according to claim 1, comprising also the step of recycling said clarified juice component to said gravity-settling zone.

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No references cited.