Simplified Sugar End Operation on De-Ionized Juices

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There are many questions of concern which are suggested to all sugar men when they are faced with the proposition of handling unbuffered juices from ion-exchange, or of a purity of 97.5 to 98.5, as against handling a highly buffered beet juice of 91.5 to 92 purity. Sugar men with their ideas of what can and what cannot be done with sucrose solutions are very much in the same boat as the housewife who thinks she cannot use beet sugar for her finer cooking and preserving but must use cane sugar.

We have gone through all the stages of development with this new process which it is possible to go through in three years' time. First we started on a four-boiling system; from there we tried a seven-boiling system with all the necessary tanks to hold the various syrups to go through seven boilings and obtain a discard. This system was fairly satisfactory as far as purity, drops, etc., were concerned—but we found that we had a terrific buildup of color, and in order to maintain purities for three white strikes of sugar before the first melt strike, it was necessary to spike second and third strikes to the point that the ratio of No. 1, No. 2, and No. 3 was considerably off balance. Both the No. 2 and No. 3 strikes had a slight off-tint. We soon realized that in order to get top quality sugar there was much left to be desired in a six- or seven-boiling system. It appeared that in boiling three white strikes of sugar to the bag the quality of the second strike was slightly off, and the quality of the third strike was not high enough to bag alone; so that in blending the scond and third strikes with the first it made practically all the sugar lower quality than we should be satisfied with by using ion-exchange.

During our 1948 campaign we did considerable experimenting with a new decolorizer resin—Duolite S-30. We first started working in strict accordance with the instructions of the manufacturer. These instructions stated that S-30 was an acid reactor, and in order to obtain the best results from this decolorizer material, it would be necessary to use it between cation and anion. We soon found that this procedure entirely defeated the whole ion exchange process. We also found that the reaction obtained from S-30 was slightly caustic, but on sugar solution slightly alkaline. It had a very good capacity for color absorption; also it tended to strengthen some of the weaker acids which would ordinarily slip the regular cation-anion treatment. We also found that where you come out of ion exchange with a water-white solution, in evaporation there takes place a very definite browning action. We found in our experiments that there were one or two things we could do to stabilize color after ion exchange without any buffers.

As a result of our experiments in 1948, we set up in 1949 so that we could use a two-boiling system, which after the first three or four days was used almost to the full extent of our resin capacity.

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The procedure in our two boiling system was to boil No. 1 pan with comparatively light brix (vis. about 89.5), not especially light for ion exchange sugar. We used a superheated wash water, nine quarts to each machine load. All the wash and all the green were used to make No. 2 white. We started by adding 100 to 200 cubic feet standard syrup. Finally the second white strike was made only of wash and green from first. On No. 2 white we separated wash and returned right back to No. 2 pan, and the green went through decolorizer (S-30 resins) and back to measuring tank bumper, through carbs, kellys, and cation anion.

There are several advantages to simplifying juice handling and boiling system:

A. Through proper handling of juices after ion exchange and careful control of temperatures after evaporators to a high of 70° C. at the melters and a high in crystallization of 75° C. it is possible to hold good color for two white pans. We made sugar from second white as good in appearance as the sugar from first, but where we used nine quarts wash on first, we used fifteen quarts on second. On the separation of wash and green we attempted to hold wash above the purity of the second pan. It is hard to hold colors beyond the second pan good enough for a third white, so after the second boil we returned the green to S-30 resins and back to the beet end.

B. In bringing the second green back to the beet end we obtained a very good elimination of invert sugar through liming and carbonating. We finished the campaign with an average invert of thick juice of .12% on dry substance. The volume of material recycled did not build up invert at all. There were days when we recycled 100% of second green, and most of the campaign we were recycling between 50% and 75%. Our average was about 66%.

C. It is easy to see that in using a two-boiling system it is possible to get away from any unusual capacity in holding tanks. About the only tanks necessary are the hy-green syrup tanks under the first white centrifugals, two pan storage tanks for standard liquor, one pan storage tank for hy-green, one second wash tank under the second white centrifugals, one second green tank under second white centrifugals, and a gravity tank on pan storage for second green feed to decolorizers. These are plus any necessary tanks to hold blended syrups for production of soft sugars.

D. The two-boiling system makes it possible to schedule evenly the pan boilings so that the sugar boiler can give maximum attention to each pan boiled with other attendant benefits, vis., (1) Materially reduced stocks as the product of each pan is materially dependent on the progress of the other pan. Very seldom did we have two pans boiling at one time, and at one time when we took stock in the middle of the campaign there were fewer than 2,900 bags of sugar in process compared to almost 8,000 bags at one time the year before. (2) It is possible to reduce total steam consumption in that the load is more constant and the boilers are not pushed at any time, attested by our

figure *Coal on beets* of 9.65%, the lowest figure for several years. (3) The discard is reduced in direct proportion to the volume of green you can recycle. It is possible to have anywhere from no discard to two or three discards, according to length of campaign and build up of raffinose sugar. (4) Greater boiler house efficiency is assured because of less fluctuation in load; the boilers can operate on the average load about 95% of the time, thus getting away from extreme peaks in load and complete dropping of load.

Ion exchange now—if we can obtain stability on resins, which looks very good by our experience—appears to be the most flexible development in the sugar field. It appears that the manufacture of sugar can now be simplified and improved so that we will be able to make sugar with a higher degree of certainty on both quality and quantity. It also opens up the possibility of making beet sugar a product of higher quality than is now credited to cane.

It now appears that with the very limited discard (two during a campaign) the extraction of sugar from beets can be held within the limits of the beet end losses plus unknown, which includes sweetening on and off and loss through inversion—all of which should be controlled to a point where it would be possible to get 97.5% to 98% total extraction. Layton sugar extraction for 1949 in granulated, brown, and liquid sugar was 96.5%,.

Brown sugar is one phase of the sugar industry which has been a field entirely reserved for the manufacturers of cane sugar. We have been able to produce only a little on a synthetic basis after making the granulated and carefully blending cane syrups to spray on the sugar crystals. It is readily seen that such a process is too expensive an addition to make to our already expensive specialty lines, which the market price set-up makes impossible to justify. Only through ion exchange is it possible to compete with cane brown sugar. It is possible to take brown off the process any place down the line to the discard stage. The only off-taste in ion exchange brown is the taste of a caramel build up. There is none of the salty, bitter taste which is so noticeable in brown cane sugar. It is entirely possible that beet soft sugar will be more in demand than cane brown sugar because of the high percentage of mineral removal and the absence of any foreign flavors other than caramel.

Liquid sugar is one of the attractive phases of ion exchange, especially where the plant is close to a large center of population where a good demand for liquid sugar is possible. In other territories it is possible to develop enough market to utilize completely any discard molasses which might be produced from an ion exchange operation and at the same time convert this discard into sweetening power of a quality and volume to justify the operation. We have used a pilot scale plant in the last two years (which have been extremely short campaigns) to decrease the cost of maintenance and hold together a full crew of key men which we would have had to decrease by four or five men otherwise.

Since the molasses market now bears a proper relationship to the price of granulated sugar, we have an added benefit to be obtained from the operation of an ion exchange plant.

After the conclusion of the 1949 sugar campaign we obtained two tank cars of straight house molasses to run for white sugar, brown sugar, and liquid sugar. We made no attempt to go the limit on white sugar extraction, but on a single pass we received 575 bags of white sugar; and with the experience gained it would be possible to make this sugar "A" grade. We also received 225 bags of brown sugar, and according to our calculations we should receive about 65 barrels of edible syrup at 70° brix.

When and if molasses becomes available to the extent that two or three months operation on molasses is practical, by the use of lime and recycling, we think it would be possible to extract easily 90% of the total sugar in the molasses as white sugar and possibly as much as 95% as white, brown, and edible syrup. We realize, of course, that the problems of molasses operation are different from beet operation; but the experience obtained shows us that it is certainly economically feasible.

Every year ion exchange is coming nearer to being the tool for sugar manufacturing which we had originally hoped it would be. In the past year we were able to get a broader insight into the eventual possibilities of the process and think we can see that it is sufficiently flexible so that the whole sugar process could be greatly simplified. Certainly it puts us in a more favorable position as compared to the cumbersome double process of raw and refined in the cane sugar industry.

We can by the use of ion exchange duplicate any standard of quality which can be set for the various sugars, and it is just possible that we can set up standards that heretofore have been unattainable.