The Steffen Process—Practical Application of Basic Principles

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In principle, there have been no new developments in the Steffen process over the last fifty years. In Claasen's "Beet Sugar Manufacture," the first edition of which was published in 1901, he says, in effect, "Molasses is mixed with water to 14° Brix or less and cooled down to the temperature of the cooling water. Powdered lime is introduced and mixed uniformly with this liquid, the recovery of sugar is best at a temperature of not over 10°-12° Centigrade." He further states, "Particular stress is laid upon pulverizing the lime because the amount used is *in* proportion to the fineness of the powder," and again "the wash water must be as cold as possible."

For more clarity and to give weight to some of the practical features of operation which experience has shown to be quite important, the statement of these principles might be expanded somewhat as follows:

1. Lime powder should be as high in CaO as possible, at least 86 percent, and should contain no appreciable amount of either over-burned or under-burned material and should be ground to a fineness of 1 percent plus 200 mesh or less.

2. The solution-for-cooler should be at least 6 percent sugar by polarization. Uniformity of the solution, both as to sugar content and volume, is essential.

3. Weights of lime in proportion to sugar in the cooler solution must be accurate within narrow limits.

4. Cooler temperature before, during and after lime addition should be held as low as the temperature of the cooling water will allow.

5. Increased cooler solution temperature, whether from heating molasses, using hot water for make-up, restricting cooler water circulation, introducing hot saccharate cake, solution or sludge, or by heating the finished cooler solution prior to filtration, should be strictly avoided for best results.

6. Lime dispersal apparatus of a type to effect rapid and intimate contact of lime and sugar and prevent the formation of lime agglomerates is advantageous, both in reducing lime requirements and increasing filtration rates.

7. The reduction of foam *in* the cooler solution during lime addition, and afterwards through the filters, to the lowest possible limits is of paramount importance. Piping, tanks, stirrers and pumps between the coolers and filters should be arranged for minimum foam production.

8. Drum filters must be maintained in good condition. Filter leaks are extremely detrimental.

9. Oscillating spray bars, efficient non-clog spray nozzles, properly spaced, together with individual strainers on each filter, are essential to optimum washing of cold cake.

10. Wash water should also be the coldest water available, and only that amount necessary to displace the waste water in the cake should be used.

[1] Great Western Sugar Company.

To combine all of these important features for optimum results is not easy, and since the Steffen process occupies the unfortunate position of being more or less of a stepchild to the main house activities of cutting beets and crystallizing sugar, it is possible that this operation does not normally receive the detailed attention which it deserves. Any excessive loss of sugar *in* Steffen waste and/or the use of excess lime can run into serious financial losses, which, obviously, are to be avoided if at all possible.

From a review of the Great Western Steffen process results for a number of years prior to 1951, it was quite apparent that full benefit of the known principles was not being realized. A full scale demonstration of the possibilities seemed to be indicated.

Based on the premise that "one look is worth a thousand words," pilot plant equipment was set up and operated to demonstrate the results obtainable under controlled conditions of time, temperature, solution concentration and lime addition. The results followed the book. Repeated tests were run with coolers held throughout the cycle at 10° C, with six to seven percent sugar in the cooler solution, and lime additions not in excess of 100 percent on sugar. Under these conditions cooler waste was uniformly under 0.50 percent sugar and the total calculated loss was well under 2.00 percent on sugar introduced. The finished cooler solution was filtered over a pilot plant size drum filter, without preheat, at the rate of 9 1/2 to 1O 1/2 sq. ft. of filter surface per ton of molasses equivalent. The advantage of low wash water temperature was also demonstrated. Wash water at 17° temperature showed an increase of 30 to 50 percent in sugar between cooler and filter waste, while wash water at 6° C. showed only a 5 to 10 percent spread. This should be expected since the colder the water the less disintegration of saccharate precipitate takes place during the filtering operation.

The supervisory and Steffen House operating personnel of this company were brought in to see the demonstration and the whole procedure discussed in detail. During these discussions it developed that various minor changes in piping, equipment and procedure gave promise of improvement in operation. Many of these adjustments were made. Two features were given particular attention: The first was to eliminate any piping or pumping arrangement which would have a tendency to produce foam. Foam retards filtration, tends to disintegrate the saccharate, and in the cooler prevents intimate contact of lime and sugar. The second point was to design some mechanical arrangement to insure prompt and intimate mixture of the ground lime with the cooler solution. Over the years, the records show that sundry and various schemes have been tried for this purpose, these schemes including sieves, bolters, blowers, spinning discs to throw the lime over the surface of the cooler liquor, etc. None of these methods has survived the test of time. Based on some previous experimental work, another idea was developed which seemed to give some promise of benficial results. This was to install two screens (about 1/8 inch woven wire mesh) set horizontally about half way down in the well of the cooler, one stationary and the other attached to an extension of the cooler propeller shaft, the two screens located as close together as possible without interference and occupying the entire cross section of the cooler well. The lime being added in more or less a continuous stream at the center of the down-flowing current

of liquor would necessarily pass both screens and be pretty well dispersed in the solution. This was done at a number of plants for the 1951 operations.

At factories where conditions were such that equipment arrangements and methods of procedure could be set up to closely approximate the pilot plant operation, the results for this past campaign were quite gratifying.

The figures in Table 1 from the Sterling factory, R. H. Myers, superintendent, and from Gering, S. L. Force, superintendent, indicate what results may be expected from close control and strict adherence to basic principles.

Table 1.—Steffen House Operating Data, Comparative Results, 1950-'51 and 1951-'52 Campaigns.

	Sterling, Colorado, Factory					Gering, Neb., Factory	
	[1]IO/8-10/18-'51 Warm Water Period	10/18-11/25 '51 Lower Temp. Cooling Water	11/25-12/17'51 Lowest Temp. Water	1951'52 Camp. Av'ges.	1950'51 Camp. Av'ges.	1951-'52 Camp. Av'ges.	1950 '51 Camp. Av'ges.
Cooler Sol. % Sugar	5.26	5.98	6.12	5.92	5.20	5.94	5.69
Cooler Waste % Sugar	.46	.23	.22	.25	.25	.36	.44
Filter Waste % Sugar	.57	.35	.32	.37	.38	.43	.48
Total Waste % Sugar	-22	.07	.07	.09	.11	.08	.13
Cold Sacc. Wash Temp. ° C.	24	16	8	13	26	11	18
Finish Cooler Temp. ° C.	23	17	14	16	17	15	19
Lime Pw'dr % CaO	88.7	88.2	89.2	88.6	89.1	88.2	86.3
Lime Add. % Sug In Mol. Wk'd.	120	106	100	104	126	113	133
Loss % Sug. In Mol. Wk'd.	4.22	2.01	1.25	1.88	2.01	1.83	2.58

[1] Some mechanical adjustments being made during this period.

In a letter in connection with his 1951-52 results, Mr. Myers comments as follows:

> "In summing up the operation of the Steffen House at Sterling the past campaign, we are listing the points which in our judgment were most responsible for the improvement:
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> "1. A good quality of burned lime, not overburned nor underburned, ground to a screen test of not over 1 percent plus 200 mesh, finer if possible. Without pretty good lime, operation is not going to be good.
>
> "2. All operation to be as cold as possible with an ample supply of cooling water.
>
> "3. Dispersal screens in all coolers. The powdered lime is well dispersed throughout the solution and more surfaces of lime are exposed for lime-sugar action.

"4. Keep foam to the minimum, especially in coolers and filters. The combined effect of eliminating 'foam makers,' together with the installation of dispersal screens and use of an effective chemical foam breaker, did a good job the past campaign.

"5. Even operation and close attention to all details in producing coolers. All finished coolers as near alike as possible and a frequent check on the operation of lime scales and lime addition.

"6. Filtering equipment in clean, serviceable condition, clean cloths, clean sprays and tight vacuum heads on all the drums."

Mr. Force at Gering has this to say:

"There was considerable improvement in our operations over the previous year. Nothing new or spectacular was tried, but, in the main, the improvement can be attributed to the time-tested principles, with even, consistent operations and close attention to detail.

"The following items are considered significant:

"1. The coldest water available was used both for coolers and for washing filters.

"2. Drum filters were put up and maintained in excellent shape.

"3. All foam-making piping arrangements were eliminated as far as possible.

"4. Run the making of coolers and the cleaning of filters on a uniform time schedule. This makes for uniform results."

Of the nine Great Western Steffen Houses, these two houses, Sterling and Gering, did the best work last year. The other houses made improvements over past performances in varying degrees. With this experience as a background, it is expected that the future will continue to show beneficial results of the educational program.