Pulp Press Water Reclamation

W. O. WECKEL[1]

UNDER THE MODERN concept of industrial practice, economical use of fresh water supplies and reduction of waste disposal have become of extreme importance. This is particularly true in the beet sugar industry where large amounts of fresh water are required and the disposal problem of each plant is equivalent to that of a fair-sized city. The two problems are closely related in that a reduction of water usage results in a lower volume of waste to be handled. In general, the best and cheapest method of attacking a waste-disposal problem is to first eliminate or reduce as much of the waste as possible.

The advent of utilization of by-products from Steffen waste and the use of continuous diffusion units for extracting sugar from beets have improved the picture greatly. Now the overall problem of waste disposal and water usage may be more realistically handled.

One of the chief wastes still requiring disposal facilities under these conditions, is pulp press water. This water, while not extremely large in quantity, is high in both solids and organic matter, hence high in B.O.D content.

Previous Work

During recent years, a considerable amount of work has been done in Europe on the return of both pulp water and pulp press water to the diffusion batteries. The literature on this subject is quite fully discussed by Wintzell and Lauritzson (6).[2] Most of the work on this subject has been with returning pulp water to the battery and in addition some have tried returning pulp press water with and without treatment.

On the basis of previous work done by others and their own work, Wintzell and Lauritzson concluded that:

1. Pulp water if sufficiently well screened can be returned to the battery separately without visible corrosion, harmful effect on battery operation, or harmful effect on juice quality.

2. By returning the pulp water, all the sugar solids and harmful nitrogen appeared to have been transferred to the pulp. The net gain was a considerable reduction in solids sewered, and a corresponding gain in pressed pulp solids without ill effects to the process.

Following two successful seasons of operation using the return of pulp water only, they instituted the total return of pulp and press waters, using an acid defecation of the latter.

[1]Chief Chemist, Spreckels Sugar Company, Spreckels, California.

[2]The numbers in parentheses refer to literature cited.

Wintzell and Lauritzson were issued patents (7) covering this acid treatment of press water which has as its essential points:

1. Addition of sulfuric acid to a pH of about 3.6
2. Clarification to separate the precipitated floc, and,
3. Centrifugal separation of the sludge.

On the basis of comparative tests, Wintzell and Lauritzson claimed the following results as compared with no return of the pulp or press water:

1. No corrosion if precaution is taken to exclude air from the acid waters and to remove sand.
2. No serious foaming if precaution is taken to avoid splashing.
3. Slight increase in battery capacity.
4. Sugar loss reduced by 0.10 percent on beets with 2 percent less draft.
5. No detectable inversion in returned water.
6. No significant change in juice quality.
7. Pulp solids increased by 0.8 to 1.0 percent on beets.
8. Pulp presses worked easier and pressed pulp moistures were reduced 1.2 percent.

Other writers, notably Backmann (1), Wescke (5), and McDonald (3) have since criticized the Wintzell-Lauritzson process as causing excessive corrosion in handling the acidified press water. McDonald (2) suggested that instead, the pulp and press water be limed to 7.0 pH and sterilized at 90 degrees centrigrade immediately before use in the battery.

Previously, various other people had tried the use of lime treatment of press water but it met with disfavor principally because of the effect of slowing the diffusion rate and the amount of nitrogen compounds returned.

Preliminary Experiments

An alternative use for lime treated press water is in the various points in the Steffen process. Most of the experiments made by the Spreckels Sugar Company in this field have been directed toward this end.

In 1939, preliminary laboratory experiments were conducted which showed that good defecation could be obtained using 0.2 percent CaO addition. The floc settled satisfactorily and was filterable through ordinary filter paper. The addition of 0.5 to 1.0 percent lime cake sludge, either before or after the lime addition, improved the settling rate and did not contribute soluble solids. The lime defecation also effectively stopped bacterial action in the clarified water. These tests indicated that the defecated water may be suitable for Steffen use.

Accordingly, a temporary installation was made in which a portion of the screened press water was piped to a spare Steffen Dorr clarifier. Upstream from the clarifier, milk of lime was added at the rate of about

0.2 percent CaO on press water. Some trouble was experienced with obtaining uniform lime addition because of the temporary arrangement. However, uniform lime addition was found to produce satisfactory clarification.

Because of the high temperature (50 to 55 degrees centigrade), of the clarified press water, it was not possible to use the entire available quantity in the solution mixer, however, on two occasions, the Steffen operating rate was reduced by half, to enable a test to be made. No adverse effects on cake purities or losses were detected. Plugging of the cold filter cloths resulted, if the returned water was allowed to become cloudy; however, with proper clarification of the returned water, the filters were not affected.

In 1940, laboratory experiments were made on washing cold cake with warm, defecated pulp press water. The conclusion was reached that no decomposition of the saccharate resulted from the use of the warm water nor was anything precipitated in the cake which might retard filtration. Drying of the cake following washing was more rapid when using the clarified press water in place of cold tap water.

Settling Tests

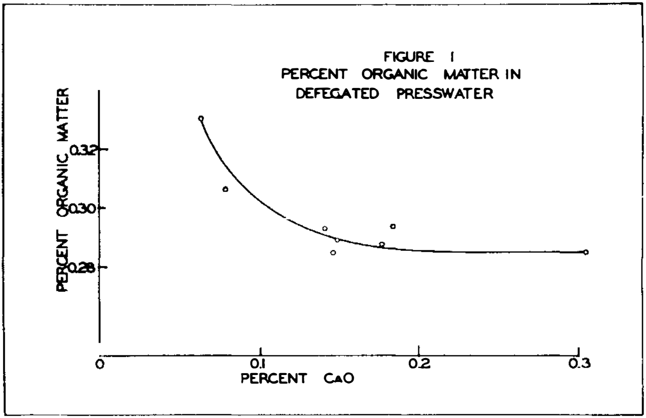
In 1947, experimental work on the subject was continued to obtain more complete information. Settling characteristics were studied in greater detail using the method described by Skaar and McGinnis (4). Preliminary bench tests indicated some differences in the settling characteristics between batch and continuous defecation so a continuous bench-scale apparatus was set up for subsequent work. Continuous operation showed improved settling against batch operation and would be much more practical in plant-scale work.

The first phase of the problem studied was the lime addition required to produce satisfactory settling and purification. Variations in press water were found to require somewhat different amounts of lime. The results obtained indicated that 0.15 percent CaO was a safe minimum addition for practically all conditions encountered. Additional liming showed no improvement in settling rate or degree of clarification. The quantity of organic matter remaining in the supernatant liquor was used as a basis for judging the degree of purification. This was also found to be quite constant beyond the previously mentioned safe minimum lime addition. Figure 1 shows a typical example.

After having determined the effect of adding various quantities of lime, recirculation was the next variable studied. This was found to be a negligible factor. Recirculation as high as ten-to-one ratio yielded no improvement in settling rate and organic matter removal.

Retention time was also tested. Somewhat as in the study of lime addition, retention beyond 4.5 minutes added no improvement to settling rate or removal of organic matter. Possibly more efficient dispersal of the lime would shorten this time as it appeared that adequate mixing was the most important factor.

The settling character information obtained in the three series of tests just mentioned was checked in a pilot installation. The results produced in the pilot plant were considerably better than the bench tests. A settling rate of 1.16 gallons of feed per minute per square foot of area was obtained at a ratio of 85 percent clear effluent to 15 percent underflow. The underflow contained 1.5 to 2.0 percent suspended solids.



Filtration Tests

A few filtration tests were conducted on the sludge in a bomb-type filter. Because of the compressibility of the cake, it was soon found that only small to moderate pressures could be tolerated in filtration. Fifteen inches of mercury pressure appeared to be optimum. At this pressure, a filtration rate of 6.2 gallons per hour per square foot of filter surface was obtained on a 30-minute cycle. These tests were all made at 50 degrees centigrade. A comparative test at 80 degrees centigrade was also made. This showed an increase in rate to 8.5 gallons per hour per square foot of filter surface.

The cake obtained in the filtration tests appeared very bulky and of a low solids content. Following one of the regular tests, the filter leaf was excessed with air at filtration pressure and the cake was dried to a solids content of 20 percent.

As a whole, the filtration tests should be viewed as being directional rather than specific data. Because of the lack of facilities, it was necessary to transport preserved material from one factory to another for the tests. This makes it impossible to say no change had occurred.

Utilization

Before the clarified press water can be effectively utilized for diluting molasses in the Steffen process, it must be cooled to a temperature approaching cold water temperature. Otherwise excessive refrigeration equipment would be necessary. This can be done most economically by a cooling tower. However, with a considerable amount of sugar and other organic matter present, it seemed possible that algae growth might present a problem in such a cooling tower. In order to check this point, a pilot cooling tower was built and operated continuously with clarified press water for 3 weeks. No evidence of algae formation was found. The clear effluent remains at approximately 12 0 pH and it seems unlikely that any algae could survive in this water.

In order to determine more accurately the effect of using clarified press water in the Steffen process, a large sample was concentrated to 6.5 percent sugar. This solution had an apparent purity of 87. Cold saccharate cake produced from this solution had an apparent purity of 96.7. Incidentally, it may also be noted here that the beets from which the press water was derived were piled beets and in poor condition. Therefore, it appears that in a conservative view, Steffens purities would not be degraded by the use of clarified press water.

Summary and Conclusions

As a whole, the tests made, clearly indicate that pulp press water can be treated successfully by means of lime defecation. The lime required is approximately 0.15 percent CaO on water. Other factors such as recirculation and retention time appear to be insignificant as long as sufficient mixing occurs prior to settling. The best settling area requirements obtained in pilot-scale tests were 1.16 gallons per minute per square foot of area at a ratio of 85 percent clear effluent to 15 percent underflow. Filtration requirements on this underflow were the only important factors not explored sufficiently. The clarified water can be successfully used in the Steffen process after cooling. This pre-cooling before refrigeration may be accomplished by means of a cooling tower without excessive algae formation.

As benefits to be derived from such a system we believe the following may be accomplished:

1. Recovery of high percentage of the sugar now lost in pulp press water.
2. Increased dried pulp solids production by return of the filtered sludge to the pressed pulp.
3. Increased amino acid content of Steffen filtrate and,
4. Reduction in both water consumption and waste disposal.

These factors exist with the either batch or continuous diffusion. Where conventional Robert-type batteries are in use, this treatment in conjunction with pulp water return to the battery should make possible even greater sugar recovery. As demonstrated by Wintzell and Lauritzson, much of the pulp water sugar would be transferred to the pulp and be recovered in the press water.

The degree of completeness of the utilization in the Steffen process will depend upon the ratio of molasses worked to beets sliced. For complete reuse of the press water, it will probably be necessary to use it for slaking lime and washing the cold cake in addition to molasses dilution.

The financial savings will vary considerably according to factory conditions but in general they appear to be quite attractive.

Literature Cited

(1) BACKMANN, A.
1945. Intern. Sugar J. 47:72.

(2) MCDONALD, J. C.
Intern. Sugar J. 46:208-10.

(3) MCDONALD, J. C.
Ibid. 47:100-101.

(4) SKAAR, K. S. AND MCGINNIS, R. A.
1944. Ind. and Eng. Chem. 36:575.

(5) WESCHKE.
1935. Centralblatt Zuckerind. p. 672.

(6) WINTZELL, T. AND LAURITZSON, T.
Am. Doc. Inst., Doc. No. 1820.

(7) WINTZELL, T. AND LAURITZSON, T.
1943. U. S. Pat. No. 2,332,823.