THE REDUCTION OF SUCROSE LOSSES IN CLARIFIERS AND MILLING TANDEMS

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(Paper read by Mr. Bruijn)*

Introduction

The first part of this paper deals with the reduction of sucrose losses in the clarifier during hours of stoppage. The second part describes experiments carried out to prevent the formation of slimes in the milling tandem and subsequent destruction of sucrose.

Part I

CLARIFIER LOSSES

During the latter half of the 1963-64 season an investigation was carried out at the Illovo factory into the deterioration of juices in the clarifier during stoppages.

Samples of clarified juice were taken from each level of a 60,000 gallon Rapi-dorr clarifier at hourly intervals, and the pH and apparent purity determined. The pattern of results was similar for all levels of the clarifier, and in this paper the figures shown are those taken from the bottom level.

To ascertain the effects of high temperatures and normal operating pH, the mixed juice was limed to pH 7.5 after primary heating to 180°F, with secondary heating to 220°F for three hours prior to a shut-down. The juice pH, apparent purity and drop in purity after various intervals of time are tabulated in Table I.

Table I

Hours of Stoppage	pH	Apparent Purity	Cumulative Purity Drop
0	7.1	86.4	—
4	6.5	84.9	1.5
8	6.4	83.0	3.4
12	6.0	82.0	4.4

After 24 hours the pH was 4.7 and the apparent purity 79.6.

This rapid deterioration of juice in the clarifier was confirmed by subsequent tests. During one shut-down of 42 hours, the apparent purity fell from 86.2 to 68.0, representing a pol loss of 7.6 tons.

In order to observe the effect of reducing the temperature and increasing the pH before shut-down, observations were made and data collected for a shut-down, for three hours prior to which the juice final temperature was dropped to 190°F and the pH raised to 8.0. The results obtained are tabulated in Table II and indicate that the purity drop was 0.9 less than for the same period in the first experiment, when the temperature was not lowered nor the pH raised.

Table II

Hours of Stoppage	pH	Apparent Purity	Cumulative Purity Drop
0	7.3	86.7	—
4	6.9	85.7	1.0
8	6.6	84.6	2.1
12	6.3	83.2	3.5

To ascertain the effect of a further reduction in temperature and a higher pH, the juice final temperature was lowered to 180° F and the pH raised to 8.5 for three hours before shut-down. The results tabulated in Table III indicate that a further reduction in the purity drop occurred.

Table III

Hours of Stoppage	pH	Apparent Purity	Cumulative Purity Drop
0	7.6	87.2	—
4	7.4	87.1	0.1
8	7.1	86.4	0.8
12	6.5	84.8	2.4

Subsequent tests followed the same general pattern as the results shown above.

A series of laboratory tests was conducted on a group of substances known as quaternary ammonium compounds. Several were tried and the most effective (taking the cost into account) was found to be a compound marketed under the brand name of Leucosan.

Leucosan is non-toxic, practically odourless and tasteless in use and is extremely soluble in water.

To examine the effect of Leucosan when used on a factory scale, an experiment was conducted over a shut-down utilizing Leucosan added to the juice in conjunction with reduced temperature and raised pH. The mixed juice was limed to pH 8.5 after primary heating to 150°F, with secondary heating to 180°F for three hours prior to a shut-down. During this period 100 ppm of Leucosan were added to the juice by a drip-feed arrangement. The pH and apparent purity of the juice in the clarifier were determined at four-hourly intervals and these are listed in Table IV.

*Owing to the author's absence discussion on this paper has not been recorded.

Table IV

Hours of Stoppage	pH	Apparent Purity	Cumulative Purity Drop
0	7.8	86.4	—
4	7.2	86.2	0.2
8	7.2	86.3	0.1
12	7.2	86.2	0.2
16	7.1	86.0	0.4
20	7.0	86.0	0.4
24	7.0	85.8	0.6

In this case crushing was resumed after 30 hours. A bulk sample of clarified juice was withdrawn from the clarifier before crushing commenced and its temperature maintained at 180°F in the Laboratory. After a total elapsed period of 36 hours, the pH was 6.6 and the apparent purity 84.8. The purity drop over 36 hours was thus 1.6.

These results indicate a considerable reduction in the purity drop of the juice compared with previous experiments where no bactericide was added.

In order to ascertain whether any Leucosan finds its way into raw sugar, the clarified juice was treated with 400 ppm of this compound, and a strike of "A" sugar boiled from the resulting syrup. The analyst's report on analyses carried out on a sample of this sugar stated that all tests for quaternary ammonium compounds were negative, and that it contained less than 10 ppm, the limit of sensitivity of the analyses.

The results of the tests described above are illustrated graphically in Figure 1.

Summary

The lowering of the temperature of the juice entering the clarifier in conjunction with raised pH does result in a reduction of the deterioration rate of the juice. However the addition of 100 ppm of Leucosan for three hours before shut-down results in sucrose losses in the clarifier being reduced to almost negligible proportions.

Part II

SUCROSE LOSSES IN THE MILLING TANDEM

Introduction

Intermittent spraying of the milling tandem with Leucosan resulted in a marked lowering of the reducing-sugars/sucrose ratio of mixed juice at Illovo and Mhlume, indicating that this product is effective in reducing sucrose losses during the milling process.

Experiments were conducted at Illovo during June and July of 1965 and at Mhlume during July and August of 1966.

Analyses

It was felt that pol, sucrose and purity figures were an unreliable guide in the evaluation of a mill sanitation programme. It was thus decided to carry out analysis for reducing sugars (by the Lane & Eynon method) on four-hourly composite samples of first expressed juice and mixed juice.

ILLOVO TEST

Spraying Equipment

At Illovo a "Hydro-air Washer" spray gun was attached to 50 ft. of oxy-acetylene hosing and 50 ft. of $\frac{3}{8}$" plastic tubing. The hose and tubing were taped together at 18" intervals, resulting in a light and flexible piece of apparatus which is very simple to operate. The hose was connected to a 100 p.s.i.g. compressed air line, and the plastic tube led into a 10 gallon drum containing the stock solution. The spray gun has controls for both compressed air and the liquid to be sprayed.

For ten days prior to the commencement of spraying four-hourly composite samples of first expressed juice and mixed juice were analysed and the average for each day is shown in Table V.

Table V

REDUCING SUGARS—SUCROSE RATIO

Day	First Expressed Juice	Mixed Juice
1	2.7	4.6
2	2.7	4.7
3	2.8	4.5
4	2.9	4.1
5	2.8	4.4
6	2.8	4.3
7	2.8	4.6
8	2.7	4.5
9	3.0	4.5
10	2.7	4.1
Average	2.8	4.4

Spraying with Leucosan was started on the eleventh day. One pint of Leucosan was diluted to two gallons with cold water. This was found to be sufficient for spraying the entire milling train, including juice screens and gutters. Spraying was done every four hours from the 11th to the 30th day of the test. A gradual lowering of the R.S./sucrose ratio for mixed juice occurred from the eleventh to the twentieth day.

The results of analyses done during the last ten days are shown in Table VI.

Table VI

REDUCING SUGARS—SUCROSE RATIO

Day	First Expressed Juice	Mixed Juice
21	2.8	4.0
22	2.8	4.0
23	2.6	3.4
24	2.8	3.9
25	2.8	4.0
26	2.9	4.1
27	3.0	4.0
28	2.7	4.0
29	2.7	3.9
30	2.8	4.0
Average	2.8	3.9

It can thus be seen that although the average figure for first expressed juice was slightly higher during the period that spraying was carried out, the figure for mixed juice was 0.51 lower.

Although purity figures do not have much significance it should be noted that the purity drop from first expressed juice to mixed juice decreased by 0.2% during the period when spraying was done.

It would be very simple to calculate an amount of sucrose saved from the above figures, but the author feels that there are too many unknown factors involved, and that such a calculation would not necessarily be valid.

The results obtained are illustrated graphically in Figure 2.

Table VII

REDUCING SUGARS—SUCROSE RATIOS

	1st Expressed Juice	Mixed Juice	Difference
1st week	3.39	4.07	0.68
Leucosan used	3.82	4.43	0.61
	3.46	3.96	0.50
	3.57	4.10	0.53
	3.23	3.65	0.42
	3.78	4.46	0.68
	3.62	4.23	0.61
Average	3.55	4.13	0.58
2nd week	3.62	3.90	0.28
Leucosan used	3.17	3.55	0.38
	2.86	3.54	0.68
	2.78	3.49	0.71
	2.91	3.57	0.66
Average	3.07	3.61	0.54
3rd week	3.78	4.27	0.49
No Leucosan	4.18	5.16	0.98
	5.21	6.20	0.99
	5.32	6.03	0.71
	5.59	6.76	1.17
	4.36	5.83	1.47
Average	4.74	5.71	0.97
4th week	4.84	6.39	1.55
Leucosan used	4.78	6.06	1.28
	4.14	5.28	1.14
	2.86	3.34	0.48
	3.03	3.79	0.76
	2.90	3.59	0.69
	3.14	3.92	0.78
Average	3.67	4.63	0.95

MHLUME TEST

In order to confirm the results of previous tests on the use of Leucosan for mill sanitation, the following experiment was carried out.

For two weeks Leucosan was applied in the usual manner i.e. it was added to the water to wash down the mills as well as to the imbibition water. During the third week no Leucosan was used and during the fourth week it was again applied normally. At each weekend stop the mills were thoroughly washed with a detergent.

The reducing sugars—sucrose ratios of first expressed juice and mixed juice were determined on eight hourly composite samples, and the daily averages are shown in Table VII.

Graphs were plotted of the difference between the reducing sugars-sucrose ratios of mixed juice and first expressed juice, and are shown in Figure 3.

It can readily be seen that the difference between the figures for mixed juice and first expressed juice rose sharply after four days when the use of Leucosan was discontinued. When it was again applied during the fourth week, the difference returned to the level obtained during the first two weeks.

The cost of Leucosan used during the test was approximately R150.00 per week.

Summary

Tests carried out at both Illovo and Mhlume indicate that Leucosan is effective in reducing sucrose losses and preventing the formation of slimes in the milling tandem. The optimum amount to be used and the method of application would best be determined for each individual factory.

Acknowledgements

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FIGURE 1

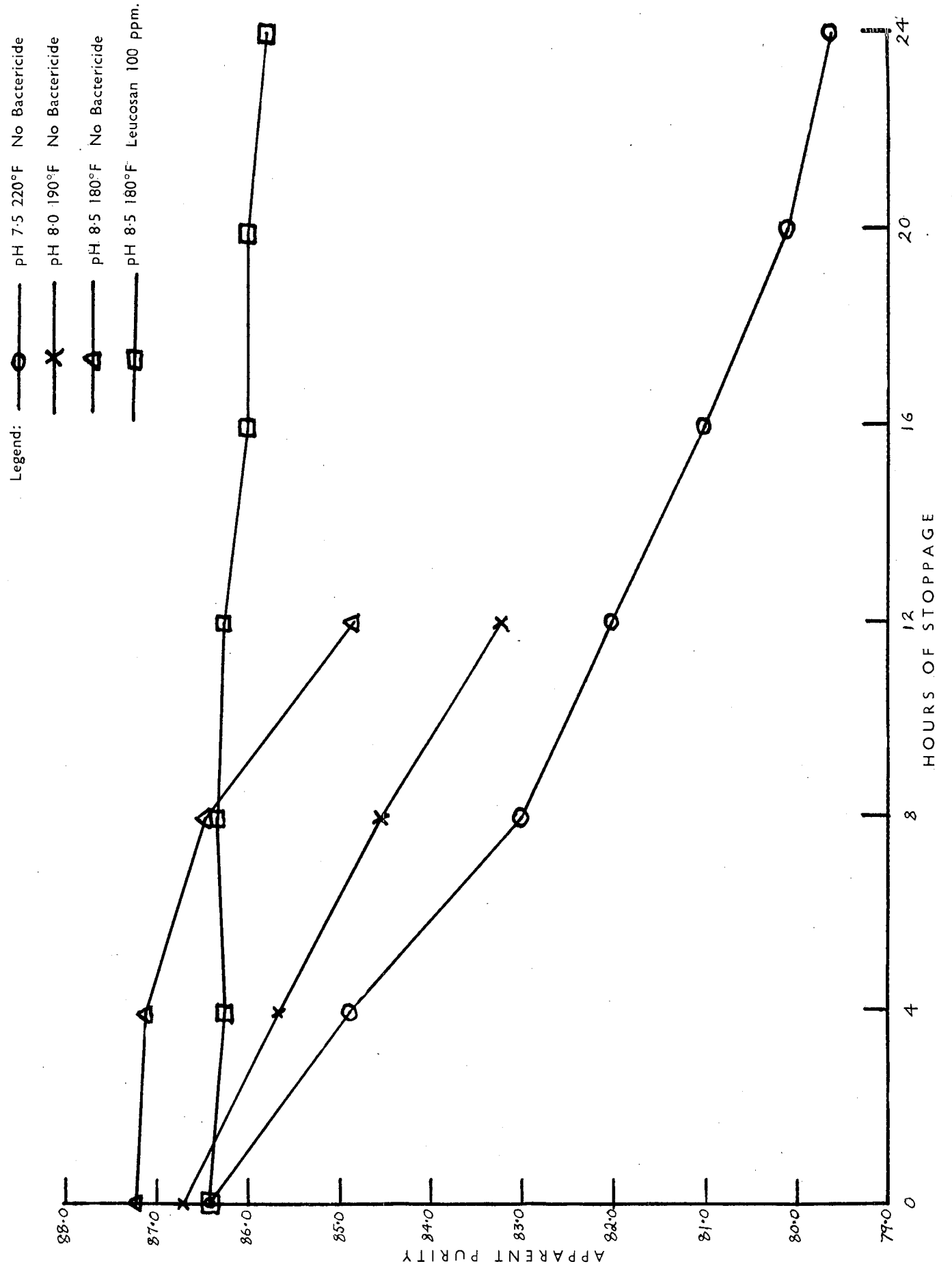
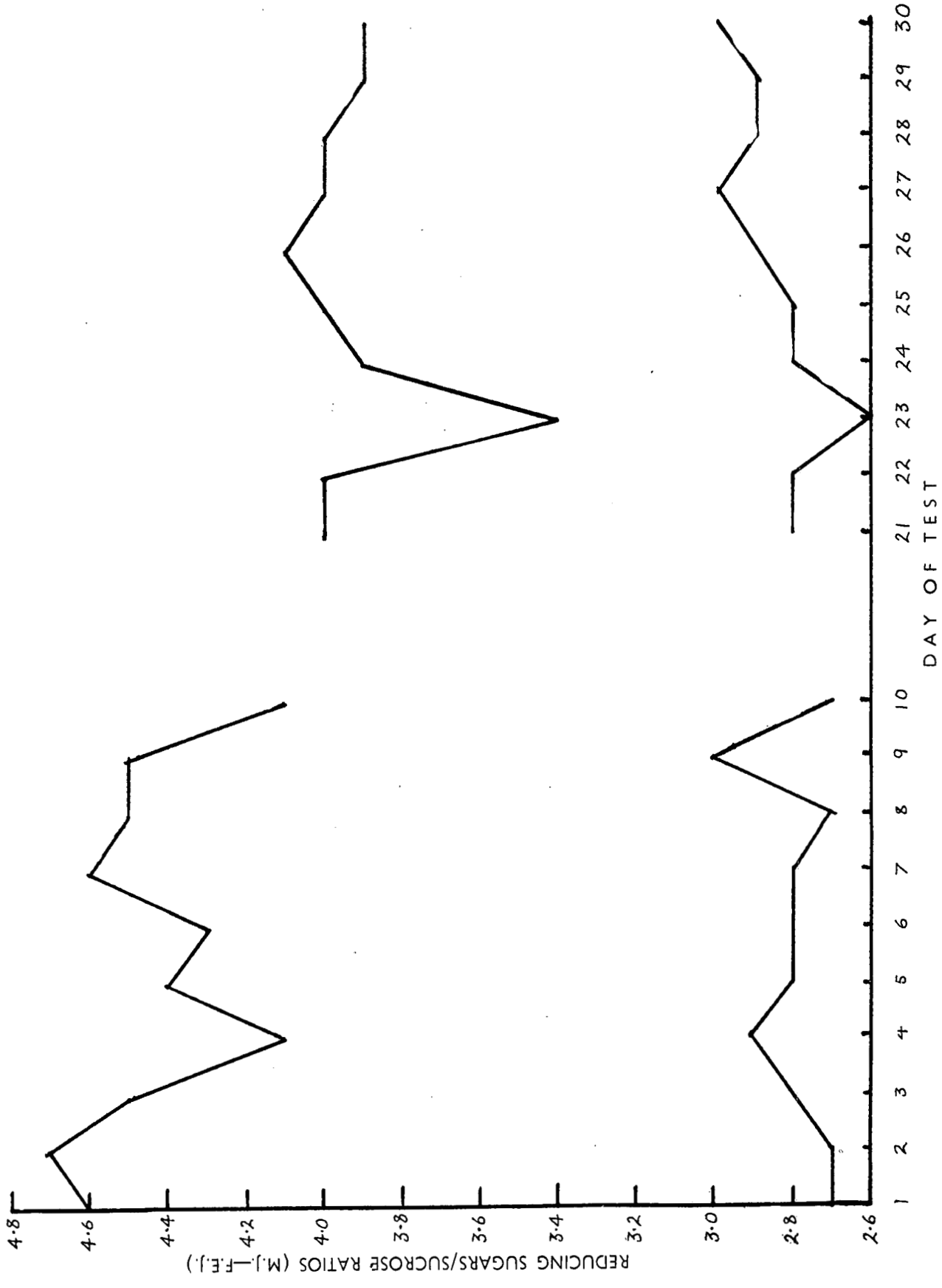

Legend:
pH 7·5 220°F No Bactericide
pH 8·0 190°F No Bactericide
pH 8·5 180°F No Bactericide
pH 8·5 180°F Leucosan 100 ppm.
APPARENT PURITY
88·0
87·0
86·0
85·0
84·0
83·0
82·0
81·0
80·0
79·0
HOURS OF STOPPAGE
0
4
8
12
16
20
24

FIGURE 2


REDUCING SUGARS/SUCROSE RATIOS (M.J.—F.E.J.)
4·8
4·6
4·4
4·2
4·0
3·8
3·6
3·4
3·2
3·0
2·8
2·6
1
2
3
4
5
6
7
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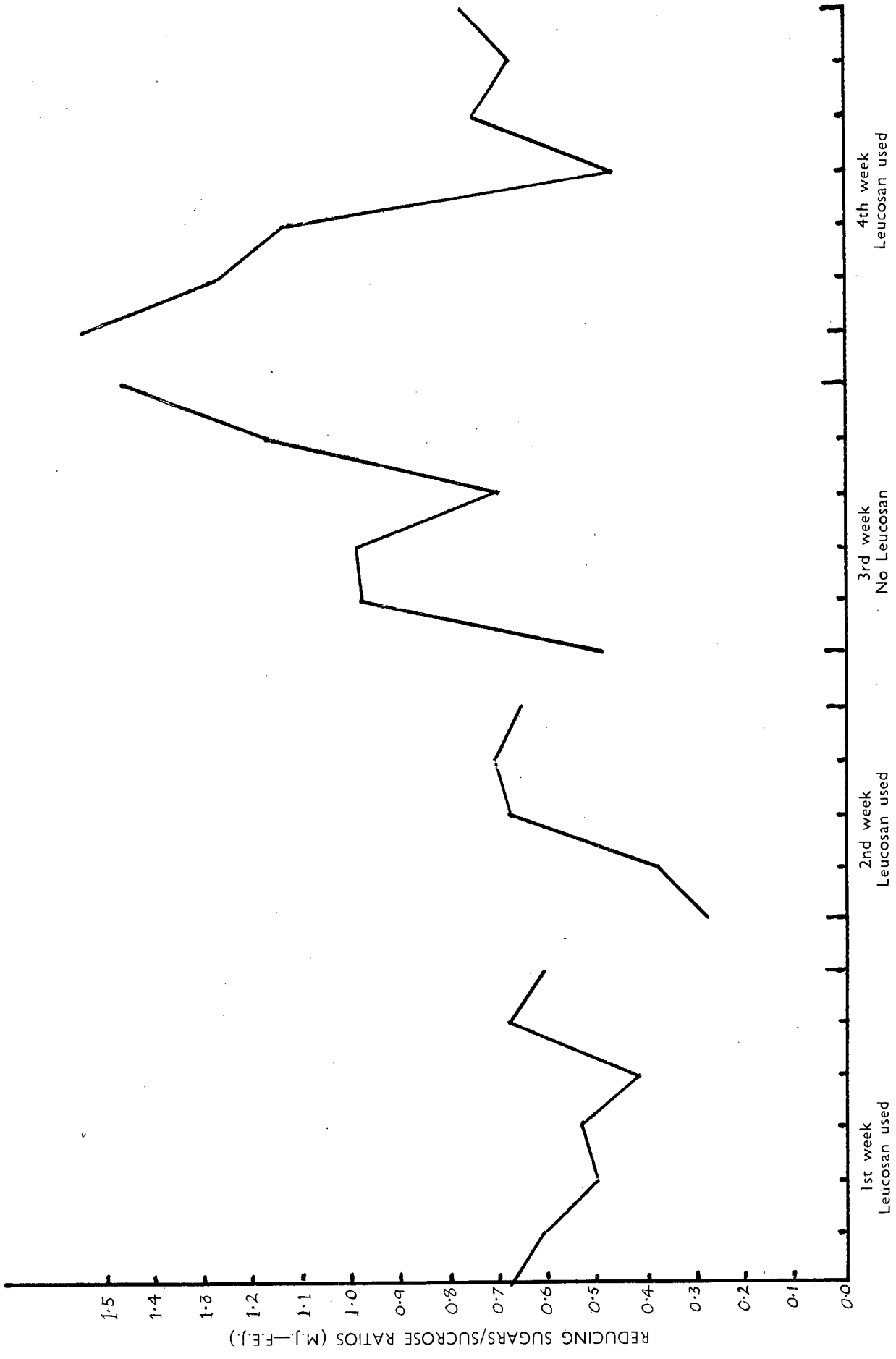
10
21
22
23
24
25
26
27
28
29
30
DAY OF TEST

FIGURE 3


REDUCING SUGARS/SUCROSE RATIOS (M.J.—F.E.J.)
0·0
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9
1·0
1·1
1·2
1·3
1·4
1·5
1st week
Leucosan used
2nd week
Leucosan used
3rd week
No Leucosan
4th week
Leucosan used