CLARIFICATION STUDIES

By G. C. DYMOND.

These studies cover several methods of juice clarification suitable to Natal conditions. They embody ordinary analytical data; cane wax retention values by precipitates; chemical requirements and the comparative removal of silica and lime salts. The methods employed were:—

1. (*a*) **The acid pre-clarification process,** as the standard of comparison. In this process 0.4 gms. of phosphoric acid paste per litre are dissolved in the cold mixed juice. SO_2 gas is then passed to give a final reaction of 3.2 pH. The juice is allowed to settle for approximately 35 minutes. With a suitable thickening device the first precipitate, or slurry, contains from 7 to 8 per cent. solids. The super-natant liquid is decanted and limed to 7.4 pH, heated to boiling and settled, whereupon a second precipitate settles out.

Three variations of the sulpho-defecation process:

(*b*) Pre-liming the cold mixed juice to 9.6 pH.

(*c*) Preliming the cold mixed juice to 10.6 pH.

(*d*) Preliming the cold mixed juice to 11.6 pH.

Thereafter sulphiting to 7.0 pH. Liming to 8.6 pH and adding 0.4 gms. of phosphoric paste per litre of juice in all cases. The juices were then heated to boiling and settled.

Sodium Carbonate.

2. The effect of adding increasing amounts of sodium carbonate to the cold mixed juice, followed by the standard acid pre-clarification process.

3. Further comparisons between: Standard acid pre-clarification, pre-liming prior to acid pre-clarification, sulpho-defecation with pre-liming to 9.6 pH, and the effect of clay on the composition of the acid pre-clarification slurry, were carried out.

Pre-liming.

The effect of pre-liming to increasing concentrations on the SO_2 requirements of the sulpho-defecation process is illustrated in the following figures. Variations occur with all mixed juice samples.

ph	**8.5**	**9.0**	**9.5**	**10.0**	**10.5**	**11.0**	**11.6**
Gms. CaO per litre ...	0.26	0.36	0.47	0.60	0.71	1.31	2.68
Lbs. CaO per ton cane	0.52	0.72	0.94	1.20	1.42	2.62	5.37
SO_2 gms. per litre ...	0.12	0.22	0.36	0.50	0.56	1.06	2.26

The following represent the averages from five composite samples:—

1. (*a*), (*b*), (*c*), (*d*) **Analyses of juices.**

Juices	pH.	Brix.	Purity.	Per cent. Reducing sugars.	Per cent. Ash.*	Gms CaO p.2.	Gms SO_2 per litre		Luximeter reading.
							temp.	Clar.	
Mixed Juice	5.06	13.70	86.0	0.33	0.48	—	—	—	—
Clarified Juices—					Carbonated (0.38)				
Acid pre-Clarification	7.0	14.10	86.3	0.40	0.48	0.56	0.72	0.40	59
Sulpho-Defecation—									
Pre-liming to 9.6 pH ...	6.9	14.15	86.8	0.39	0.47	0.90	0.69	0.37	55
Pre-liming to 10.6 pH ...	6.8	14.06	86.6	0.38	0.45	1.42	0.98	0.36	58
Pre-liming to 11.6 pH ...	7.0	13.60	88.0	0.37	0.38	3.56	2.98	0.36	58

* Sulphated Ash.

Comparison of precipitates.

Precipitates.	Gms. solid per litre.	Wax per cent.	gms. Ash per cent.	Total gms. solids per litre.	Total gms. wax per litre.	Total gms. ash per litre.
Acid pre-clarification—						
1st ppt. or slurry ...	4.98	31.33	19.16	10.63	1.97	2.99
2nd precipitate ...	5.65	7.30	36.2			
Sulpho-defecation—						
Pre-liming to 9.6 pH	8.16	17.47	22.0	8.16	1.42	1.80
Preliming to 10.6 pH	10.57	13.32	29.6	10.57	1.41	3.13
Preliming to 11.6 pH	14.27	9.14	59.0	14.27	1.30	8.42

Comparative ash analyses of clarified juices.

Ash Analysis	Gms Ash per litre	SiO_2 per cent.	Gms SiO_2 per litre	CaO per cent.	Gms CaO per litre	SO_3 per cent.	Gms SO_3 per litre
Mixed Juice	3.9	17.25	0.673	5.7	0.22	16.4	0.639
Clarified Juices—							
Acid pre-clarification ...	3.8	2.15	0.081	14.8	0.56	24.7	0.939
Sulpho-Defecation—							
Pre-liming to 9.6 pH	3.8	3.50	0.133	15.1	0.57	23.7	0.901
Pre-liming to 10.6 pH	3.7	3.65	0.135	13.2	0.49	23.6	0.873
Pre-liming to 11.6 pH	3.1	4.50	0.140	9.0	0.28	18.8	0.583

Comparison of the ash contents of precipitates.

Ash of Precipitates	Gms Ash per litre	SiO_2 per cent.	Gms SiO_2 per litre	CaO per cent.	Gms CaO per litre	SO_3 per cent.	Gms SO_3 per litre
Acid pre-clarification—							
1st ppt. or slurry... ...	0.954	85.0	0.811	Trace	Trace	10.7	0.102
2nd precipitate	2.04	0.04	0.001	43.96	0.897	11.67	0.238
Sulpho-Defecation—							
Pre-liming to 9.6 pH...	1.795	29.87	0.536	30.35	0.545	5.73	0.103
Pre-liming to 10.6 pH...	3.129	20.94	0.655	36.70	1.148	7.57	0.237
Pre-liming to 11.6 pH...	8.419	8.51	0.716	41.64	3.505	12.57	1.058

Interpretation of results.

Comparison of juices. Significant differences between the four methods are, an increase in purity with a lower total ash, when pre-liming to 11.6 pH in the sulpho-defecation process. Thus:—

	Mixed juice.	Acid pre-clarification.	Sulpho-defecation at		
			9.6 pH.	10.6 pH.	11.6 pH
Apparent purity ...	86.0	86.3	86.8	86.6	88.0
Ash per cent.	0.48	0.48	0.47	0.45	0.38

Considering the increased amounts of sulphur and lime required when pre-liming to 11.6 pH, this process appears unjustified from the analytical results obtained. Thus:—

	Sulphur			Lime			Phosphoric Paste		
	Gms SO_2 per litre	lbs. Sulphur per ton cane	Mill average 1950 lbs.	Gms CaO per litre	lbs. per ton cane	Mill average 1950	Gms per litre	lbs. per ton cane	Mill average 1950
Acid pre-clarification process	0.72	1.42	—	1.24	2.44	—	0.4	0.79	—
Sulpho-Defecation—									
Pre-liming to 9.6 pH	0.69	1.36	—	0.90	1.78	—	0.4	0.79	—
Pre-liming to 10.6 pH	0.98	1.93	—	1.42	2.83	—	0.4	0.79	—
Pre-liming to 11.6 pH	2.98	5.88	2.27	3.56	7.03	5.49	0.4	0.79	1.04

Comparing the acid pre-clarification process with sulpho-defecation when pre-liming to 11.6 pH with a SO_2 content of 2.98 gms. per litre, the comparative chemical requirements and their value, based on a 600,000 ton cane crop, would be as follows:—

	Sulphur.	Lime.	Phosphoric paste.
Acid pre-clarification—			
Tons required	213	333 / 582	232
Sulpho-defecation—			
Pre-liming to 11.6 pH	873	3442	232
Increase	660	2577	Nil
Landed price at Darnall ...	£19.65	£3.08	£35.98
Increased cost...	£12969	£7937	Nil

The total increased cost is therefore £20,906. In actual practice the figures for the 1950 season at Darnall were:—

	Total cane.	Sulphur.	Lime.	Phosphoric Paste.
Sulpho-defecation—				
Tons crop, 1950	705,464	681	1,647	312
Calculated on	600,000	579	1,259	265
Acid-preclarification ...	600,000	213	865	232
Increase over acid-pre-clarification	—	366	394	33
Increased cost ...	—	£7,192	£2,750	£1,187

The total increased cost of sulpho-defecation over the acid-preclarification process would be £9,592.

It appears from these results, so far, that in order to attain the maximum increase in apparent purity with a reduction of total ash and lime salts in the final clarified juice, liming to 11.6 pH is necessary, as below this figure these values tend to disappear. To attain these benefits extra chemicals worth over £20,906 per 600,000 tons of cane are required, giving a 35 per cent. increase in the amount of filter cake solids produced.

All these experiments were conducted under laboratory conditions. Clarified juices from the factory usually compare unfavourably with juices prepared in the laboratory.

Cane Wax.

Comparison of Precipitates. Wax retention.

This table shows that the total gms. of solids formed in the two precipitates of the acid pre-clarification process are approximately equal in quantity to those formed in the sulpho-defecation process, when pre-liming up to 10.6 pH. In the latter case, however, 66 tons more sulphur on a 600,000 ton cane crop, with a corresponding increase in lime, were used. This means, since the gms. solids removed were approximately equal, that more non-sugars were removed in the acid pre-clarification process.

When the juice is pre-limed to 11.6 pH there is an increase of 35 per cent. in total solids, which means an additional 35 per cent. of filter cake solids.

A further important point, however, lies in the wax retention values of the precipitates. In the acid pre-clarification process 1.97 gms. of cane wax are retained per litre in the two precipitates. To what extent this represents the total present is discussed in a later section (see Clay).

In the sulpho-defecation processes this amount is progressively and positively less, as shown in the following table:—

	Total gms. wax per litre juice.	Lbs. per ton cane.	Retention per cent.	Tons recoverable per 600,000 tons cane.	Tons gone in fabrication.
Acid preclarification—					
1st ppt. or slurry:	—	—	—	—	—
2nd precipitate...	1.97	3.79	100.0	1,137	—
Sulpho-defecation—					
Preliming to 9.6 pH	1.42	2.80	73.9	840	297
Preliming to 10.6 pH	1.41	2.78	73.3	834	303
Preliming to 11.6 pH	1.30	2.57	67.8	991	366

This means that on a 600,000 ton cane crop 366 tons of cane wax are not retained and eliminated by the precipitate obtained by the sulpho-defecation process when pre-liming to 11.6 pH and therefore pass over into sugar fabrication. This can only have a deleterious effect, but to what extent in terms of viscosity is unknown.

From a wax recovery angle, the retention of the highest percentage of wax in the slurry is obviously of importance, unless the second precipitate is also used.

Ash analyses of clarified juices and precitipates.

Carbonated ash.	Mixed juice.	Acid pre-clarification.	Sulpho-defecation at		
			p.6 pH.	10.6 pH.	11.6 pH.
SiO_2 gms. per litre juices	0.673	0.081	0.133	0.135	0.140
SiO_2 gms. in precipitates	—	0.812	0.536	0.655	0.716
Total	0.673	0.893	0.669	0.790	0.856
CaO gms. per litre juices	0.22	0.56	0.57	0.49	0.28
CaO gms. in precipitates per litre juices	—	0.897	0.545	0.148	3.505
Total	0.22	1.457	1.115	1.638	3.785
SO_3 gms. per litre juices	0.639	0.939	0.901	0.873	0.583
SO_3 gms. in precipitates per litre juices ...	—	0.340	0.103	0.237	1.058
Total	0.639	1.279	1.004	1.110	1.641

Clarified juices.

Comparing the first three processes, i.e. acid pre-clarification, sulpho-defecation at 9.6 and 10.6 pH, there appears to be a better elimination of silica in the acid pre-clarification process, but the total ash and lime salts are practically the same.

It is significant that the SiO_2 in all cases exceed that originally present in the mixed juice, so that this can only have been derived from the lime under the conditions of each process.

When pre-liming to 11.6 pH the silica is higher, but the total ash and lime salts are significantly lower.

Summary.

The sulpho-defecation process when pre-liming to 11.6 pH in order to obtain approximately 3 gms. of SO_2 per litre, costs an extra £20,906 on a 600,000 ton cane crop, as compared with the acid pre-clarification process.

In the acid pre-clarification process, 1,137 tons of cane wax are retained by the precipitates on a 600,000 ton cane crop. In the sulpho-defecation process only 771 tons are retained, so that 366 tons go into the sugar fabrication department.

On the benefit side, the sulpho-defecation process at high liming levels shows in this series an increase in apparent purity of 1.4°, with a reduction in total ash and lime salts, but with a 35 per cent. increase in the amount of filter cake solids produced.

2.—THE USE OF Na_2CO_3 IN JUICE CLARIFICATION.

In order to determine the value, if any, of using Na_2CO_3 in juice clarification, the following experiments were carried out.

Each series consists of five separate tests, consisting of mixed juice, acid-preclarification juices, ditto with the addition of 0.4 gms. of Na_2CO_3 per litre of mixed juice, ditto with the addition of 0.8 gms. of Na_2CO_3.

The average results were as follows:—

Analysis of Juices	Brix	Purity	Red Sugars	Ash* per cent.	Gms CaO per litre	SO_2 per temperature	Gms litre clarification	Luxi-meter
Mixed Juice	14.58	87.2	0.30	0.48	—	—	—	—
Clarified Juices—								
Acid pre-clarification ...	15.28	87.4	0.32	0.47	1.54	0.65	0.38	62
+0.4 gms Na_2CO_3 p.l.	15.28	87.6	0.33	0.49	2.04	0.80	0.52	62
+0.8 gms Na_2CO_3 p.l.	15.26	88.7	0.32	0.40	2.06	1.02	0.49	62

* Sulphated Ash.

Precipitates	Solids gms per litre	Wax per cent.	Ash per cent.	Total gms solids per litre	Total gms Wax per litre	Total gms Ash p.l.
First precipitate or slurry—						
Acid pre-clarification ... ditto	4.9	31.1	19.9	—	(1.52)	(0.975)
+0.4 gms Na_2CO_3 p.l. ditto	5.01	30.4	18.1	—	(1.52)	(0.921)
+0.8 gms Na_2CO_3 p.l.	5.09	29.4	20.5	—	(1.50)	(1.043)
Second precipitate—						
Acid pre-clarification ... ditto	4.86	7.90	40.0	9.76	1.90	2.89
+0.4 gms Na_2CO_3 p.l. ditto	5.26	6.50	39.2	10.27	1.86	2.96
+0.8 gms Na_2CO_3 p.l.	5.90	7.0	42.4	10.99	1.91	2.84

Ash Analyses, clarified juices and precipitates.

Juices	Gms Ash per litre*	SiO_2 per cent.	Gms SiO_2	CaO per cent.	Gms CaO per litre	SO_3 per cent.	Gms SO_3 per litre
Mixed Juice	4.1	37.6	1.54	2.4	0.10	13.0	0.53
Clarified Juices—							
Acid pre-clarification ... ... ditto	4.0	2.0	0.8	14.4	0.58	26.8	1.07
+0.4 gms Na_2CO_3 p.l. . ... ditto	4.1	1.9	0.8	13.2	0.54	26.1	1.07
+0.8 gms Na_2CO_3 p.l.	4.1	1.7	0.7	11.2	0.46	25.4	1.04
		* Carbonated ash.					
First precipitate or slurry—							
Acid pre-clarification ... ... ditto	0.98	75.4	.74	Tr.	—	Tr.	—
+0.4 gms Na_2CO_3 p.l. . ... ditto	0.91	77.9	.71	Tr.	—	Tr.	—
+0.8 gms Na_2CO_3 p.l.	1.04	75.6	.79	Tr.	—	Tr.	—
Second Precipitate—							
Acid pre-clarification ... ... ditto	1.94	3.8	0.07	54.5	1.06	6.5	0.13
+0.4 gms Na_2CO_3 p.l. . ... ditto	2.06	2.8	0.06	51.5	1.06	11.55	0.24
+00.8 gms Na_2CO_3 p.l.	2.50	6.3	0.16	49.5	1.24	31.86	.080

Interpretation of results.

There is a significant rise in purity in this series when using 0.8 gms. of Na_2CO_3 per litre of mixed juice, similar to that obtained when pre-liming in the sulpho-defecation process to 11.6 pH.

As was to be expected, there is a rise in the quantity of SO_2 absorbed with an increase in lime requirements. The ash is slightly lower. The effect of adding Na_2CO_3 on the ash content of the clarified juice varies in a few cases from 50 per cent. to nil. The reason is at present unknown. This may account for the periodic popularity of using Na_2CO_3 in the past.

The amount and value of the extra sulphur used is as follows:—

	Gms. SO_2 per litre tempered juice.	Lbs. SO_2 per ton cane.	Tons sulphur per 600,000 tons cane.
Acid pre-clarification	0.65	1.28	192
Ditto + 0.4 gms. Na_2CO_3 per litre	0.80	1.58	237
Ditto + 0.8 gms. Na_2CO_3 per litre	1.02	2.01	302

This means an increase in cost of extra sulphur on a 600,000 cane crop of £885 when using 0.4 gms. per litre and £2,162 when using 0.8 gms. of sodium carbonate per litre.

For this increased cost of sulphur, plus the cost of approximately 460 tons of Na_2CO_3 at a landed cost of £18 per ton = £8,280, there is the increase in purity of 1.2° plus an irregular but average slight reduction in SiO_2 and CaO in the clarified juice; while on the debit side there is the introduction of over 400 tons of mesaligenic sodium salts.

On these facts the use of Na_2CO_3 in the acid clarification process is not warranted.

3.—FURTHER STUDIES.

Comparisons are made between the standard acid pre-clarification process, pre-liming prior to acid pre-clarification, sulpho-defecation with pre-liming to 9.6 pH and the effect of clay on the first precipitate or slurry.

This series consist of ten comparative samples.

Clarified Juices	pH	Brix	Purity	Red sugars	Ash per cent.*	SO_2 gms per litre clarified juice	Luximeter
Mixed Juice	4.96	14.70	86.1	0.44	0.44	—	—
Clarified Juice—							
Acid pre-clarification	6.7	15.44	86.8	0.48	0.45	0.36	61
Pre-liming to 7 pH the Acid pre-clarification	6.8	15.53	86.9	0.46	0.46	0.41	62
Sulpho-defecation, pre-liming to 9.6 pH	6.6	15.25	86.6	0.48	0.43	0.25	55

* Sulphated Ash.

Precipitates	Solids gms per litre	Wax per cent.	Ash per cent.	Total gms solids per litre	Total gms Wax per litre	Total gms Ash p.l.
First precipitate or Slurry—						
Acid pre-clarification	4.51	29.23	19.3	—	—	—
ditto, pre-liming to 7 pH	4.56	28.69	18.8	—	—	—
Sulpho-defecation, pre-liming to 9.6 pH				Nil		
Second precipitate—						
Acid pre-clarification	3.49	9.64	40.5	8.00	1.66	2.28
ditto, pre-liming to 7 pH	4.91	7.89	44.3	9.47	1.70	3.04
Sulpho-defecation, pre-liming to 9.6 pH	7.77	18.30	25.3	7.77	1.42	1.96

Ash anaylses, juices and precipitates.

Juices	Gms Ash per litre	SiO_2 per cent.	Gms SiO_2	CaO per cent.	Gms CaO per litre	SO_3 per cent.	Gms SO_3 per litre
Mixed Juice	3.8	15.1	0.57	6.9	0.26	2.3	0.09
Acid pre-clarification	3.9	2.2	0.08	15.0	0.58	2.7	0.10
ditto Pre-liming to 7.0 pH	4.0	2.4	0.10	14.1	0.56	2.9	0.11
Sulpho-defecation, pre-liming to 9.6 pH	3.6	4.3	0.15	14.9	0.54	2.8	0.10

NOTE.—Ash analyses of the foregoing juices and precipitates in this series were carried out through the co-operative help of he C.S.I.R.

Precipitates	Gms Ash per litre	SiO_2 per cent.	Gms SiO_2 per litre	CaO per cent.	Gms CaO per litre	SO_3 per cent.	Gms SO_3 per litre
First precipitate—							
Acid pre-clarification	0.87	77.24	0.67	2.60	0.02	Nil	—
ditto, pre-liming to 7.0 pH	0.86	74.23	0.64	3.18	0.03	Nil	—
Sulpho-defecation, pre-liming to 9.6 pH	—	—	—	—	—	—	—
Second precipitate—							
Acid pre-clarification	1.41	3.96	0.06	50.74	0.72	10.39	0.15
ditto, pre-liming to 7.0 pH	2.18	3.83	0.08	49.55	1.08	15.99	0.35
Sulpho-defecation, pre-liming to 9.6 pH	1.96	31.32	0.61	29.73	0.58	1.98	0.04

Interpretation of results.

The foregoing series confirm the results obtained in series 1. There is no significant difference in either purities or ash percentages.

Considering the increase in lime and sulphur, no advantage occurred by pre-liming to 7.0 pH in the acid pre-clarification process. As with the use of Na_2CO_3 this may be a seasonal result, as in previous years better final clarity was observed.

With the acid pre-clarification process with and without pre-liming a somewhat better elimination of silica was observed.

	Gms. SiO_2 per litre clarified juice.	Gms. SiO_2 in precipitates per litre of juice.
Acid pre-clarification	0.08	0.73
Acid pre-clarification, pre-liming to 7.0 pH	0.10	0.73
Sulpho-defecation, preliming to 9.6 pH	0.15	0.61

Lime salts were the same in each case but, as in series 1, sulpho-defecation gave the lowest wax retention and clarity.

Wax retention and the use of clay.

From a sugar angle, the amount of wax retained by both precipitates is important. From a wax recovery angle, the amount of wax retained by the first precipitate or slurry is important, unless both can be used for this purpose.

On an average 80 per cent. of the cane wax is retained by the slurry. Individual minimum and maximum figures are 61 per cent. and 85 per cent.

In a series of six, (1) the acid pre-clarification process was compared with (2) pre-liming to 7.0 pH, (3) sulpho-defecation with pre-liming to 9.6 pH, and (4) the addition of 2.4 gms. of clay to the acid pre-clarification process.

The only significant differences were:—

	Luxi-meter.	Total gms. solids.	Solids in slurry.	Wax per cent.	Clay ppt. gms. wax per litre.	Total wax per litre.
1 ...	62	8.19	4.73	29.58	1.40	1.75
2 ...	59	9.72	4.79	29.01	1.39	1.78
3 ...	57	8.22	8.22	18.45	—	1.52
4 ...	63	13.98	7.95	18.17	1.44	2.04

From these figures it would seem as though the clay precipitate entrains a negligible amount of extra wax. This was confirmed by the following experiment, in which a progressively increasing amount of clay was added:—

Slurry.	Ccs. ppt. one litre one hour.	Gms. solids in slurry.	Wax per cent.	Gms. wax per litre.	Second precipitate. Gms. solids per litre.	Wax per cent.*	Gms. wax per litre.
1	90	3.76	26.82	1.01	4.78	7.23	0.345
2	95	4.20	25.33	1.06	4.67	7.46	0.348
3	115	4.95	23.94	1.18	4.74	8.70	0.412
4	130	5.37	22.08	1.19	5.13	8.63	0.442
5	140	5.82	19.64	1.14	4.82	5.67	0.273
6	155	6.84	16.23	1.11	5.15	7.01	0.361

* Variations probably due to irregular wax flotation due to heating on hot plates.

It is obvious from these results that no beneficial results accrue from the addition of clay. On the contrary, the solids per litre may be doubled with increased difficulties in recovery of sucrose.

GENERAL SUMMARY.

The following significant points were demonstrated under the conditions of the experiments:—

1. The acid pre-clarification process on a cane crop of 600,000 tons uses 660 tons less sulphur and 2,577 tons less lime than the sulpho-defecation process when pre-liming to 11.6 pH.

For this increased cost of £20,906 there was an increase in purity of 1.7° and a drop of 0.10 in total ash under laboratory conditions. As a rule factory juices were inferior in clarity to those prepared in the laboratory.

2. Comparisons were also made with sulpho-defecation juices pre-limed to 9.6 and 10.6 pH. The purity increase and reduction in total ash then disappeared.

3. Generally acid pre-clarification juices were brighter and kept longer, the degree being a seasonal function.

4. Compared with present methods where up to 3 gms. of SO_2 are used per litre, there is a reduction of 35 per cent. of total filter cake solids produced.

5. **Wax retention.** The sulpho-defecation methods do not retain wax as well as the acid pre-clarification process. When pre-liming to 11.6 pH a loss in retention on a 600,000 tons cane crop can amount to 366 tons.

6. **The use of sodium carbonate** is not warranted by the results obtained. Exceptional cases do occur when the total ash is considerably reduced, but on the average the small reduction in silica and lime salts do not by any means make up for the introduction of sodium salts into process, nor the cost of the sodium carbonate used.

7. **The use of clay.** The wax per cent. dry solids in the slurry may vary from 25 to 35 per cent. and in the second precipitate from 4.5 to 18 per cent. This means that on an average 80 per cent. of the cane wax is precipitated in the slurry, the extremes being 61 to 85 per cent.

The introduction of approximately 2 gms. of clay per litre doubles the solids but no more wax is apparently entrained. This may be due to the wax not being in a form in which it can be occluded in another precipitate.

No other benefits were observed, so that the use of clay merely increases the amount of filter cake without any observable benefits.

8. In this paper no reference has been made in respect of developments in the treatment of the slurry or of the methods used for wax recovery, as this forms part of the research in which the C.S.I.R. are actively participating. The quantity of protein in the slurry solids after the extraction of wax, and which ranges from 9 to 21 per cent., is also an important subject of further research.

Mr. Pearce thanked Mr. Dymond for his very thought-provoking paper, and went on to mention the case of an American company which had entered into a contract with one of the U.S.A. sugar companies for the production of wax from raw material supplied by the sugar factory. This contract was proving very profitable to both sides, and Mr. Pearce expressed the hope that Mr. Dymond's process could be similarly dealt with in this country.

Mr. Walsh enquired whether Mr. Dymond would care to indicate by means of a simple flow sheet, how the acid pre-clarification would be applied.

Mr. Dymond, by means of an illustration on the blackboard, showed how, after adding the desired amount of phosphoric paste, usually enough to give a 0.03 per cent. concentration of P_2O_5, the mixed juice would be sulphited by injection, to a pH of 3.2. Accurate recording devices would be necessary. The precipitate settled in 35 minutes and would be thickened up to 8 per cent. solids by a standard continuous type of settler. The slurry on first precipitate would now occupy approximately 10 per cent. of the total volume of juice. The supernatant liquid would be drawn off, limed, heated and settled. The slurry would be first counter-washed to remove the sucrose, then either autoclaved and filtered or centrifuged to remove the heavy solid and then heated to 90° centrigade and the wax floated.

Dr. Douwes Dekker mentioned that the conclusions given in Mr. Dymond's paper gave no indication of the enormous amount of work which he had devoted to his subject, and that he was to be congratulated on his unremitting efforts. One point which was stressed by the paper was the high costs of our sulpho-defecation process, which in comparison with the same process as applied in other countries, were

excessive. Dr. Douwes Dekker admitted that the refractory nature of the Natal juices was a contributory factor to these high costs. He then asked Mr. Dymond if he had analysed final molasses to see how much wax went from the juice into the factory processes, and concluded by suggesting that a comparison between two different types of clay applied to the process might give a basis of comparison on the usefulness of the product in obtaining better results.

Mr. Dymond replied that he had not analysed final molasses for wax content, this being a difficult matter in which to obtain accurate results. He remarked, however, that since more wax was recoverable from the first and second precipitates of the acid pre-clarification process than from any other method, it seemed safe to conclude that a fair amount was going into fabrication with the use of our present system. Replying to Dr. Douwes Dekker's query, Mr. Dymond said that he had not compared different types of clay, but that in his opinion clay added to the difficulties of the factory processes.

Mr. Elysee enquired whether inversion did not occur during the time it took the precipitate to emerge.

Mr. Dymond replied that inversion was so little as to be unworthy of consideration, and that with the continuous process the removal of the slurry was not difficult.

Mr. Lewis remarked that Dr. Douwes Dekker had referred to the difficult clarifying qualities of the Natal juices, and that Mr. Dymond also had referred to the difficult juices experienced at Darnall during the 1950-51 season. Mr. Lewis enquired what these difficulties were; were they controllable, were they determinable, and had allowance been made for them in budgetary control ?

Mr. Dymond replied that after three years' work on the acid pre-clarification process he had some knowledge of the variables which occur. For instance, in the first precipitate the colour might vary from light yellow to black, the quality differing accordingly. As a guess, Mr. Dymond said that these differences might be due to the protein content of the juices, which might show anything from a 10 to 21 per cent. variation. In his experience, Brazil was the only other country whose juices even nearly approximated ours.

Dr. Douwes Dekker added to Mr. Dymond's statement by saying that, in his opinion, the difference between Natal juices and those of other countries lay in their organic content, and assured Mr. Lewis that allowance had been made for the variations in factory control figures. He added that Boiling House Performance was the most suitable figure at the moment on which to judge the performance of a Natal mill.

Mr. Main enquired whether Mr. Dymond had taken lime into consideration when contemplating the variations in Natal juices, and cited an experience which he had encountered when using lime of a different CaO content from that usually employed.

Mr. Dymond replied that he had had no difficulties with lime, from whatever source obtained, the lime in this country seemingly being of a good standard. He admitted, however, that the increase in silica, as shown in his figures, would be caused by the silica in lime.

Dr. Douwes Dekker said a few words on the properties of magnesium oxide as applied to the clarification process some time ago in America.

Mr. Pearce remarked that Mr. Dymond's paper had provoked much discussion and called on the members to signify their appreciation of the paper in the usual way.