

# SOME OBSERVATIONS ON THE FILTERABILITY OF NATAL RAW SUGARS

By J. B. ALEXANDER

It is fairly common knowledge that sugars originating from Natal do not enjoy a reputation of possessing good filtration qualities in the refinery. It was argued therefore that it was high time that we endeavour to obtain some understanding of the causes of this poor filterability of our raw sugars. Although some good work has been done in the past (evidence of which may be found in the S.A.S.T.A. Proceedings) using the Elliot filtration apparatus, doubt has been thrown on the value of the results in view of the rather large difference between the conditions of the test and those experienced in practice.

Our first endeavour was therefore to design some type of filtration test which could be carried out under conditions more closely resembling those used in refinery operation. A review of the literature revealed that the Research Laboratory of Johns-Manville<sup>1</sup> had designed a pressure filtration apparatus to determine the filtration rate of sugar solutions. Both American and Australian reports of this "bomb-type" filtration apparatus had expressed favourable correlation of results with refinery experience. An apparatus of this type was therefore constructed at the S.M.R.I. whereby filtrations could be carried out in the pressure range 0-100 p.s.i. and at temperatures up to 100°C. A description of the filtration test is given at the conclusion of this paper.

In attempting to determine the effect which various impurities present in the raw sugar crystal can have on the filtration characteristics of a sugar it was decided that the method of addition of the suspected impurities would be unsatisfactory, since it is obvious that the physical state in which the impurities are dispersed in a solution can have a marked effect on the rate at which the solution filters. Hence the alternative procedure of determining the amount of impurities together with filtration characteristics for a number of samples was adopted in an effort to ascertain whether any correlation existed. In the choice of impurities which might be expected to affect filtration, the fairly-well established concept that only those impurities which are removed by filtration (viscosity excepted) can affect filtration rate, was accepted. The three impurities chosen initially for tests were phosphates, silica and starch. The determination of "gums" in affined sugar by the normal gravimetric method was not found to be sufficiently reproducible for the accuracy required and since starch was found to constitute a major portion of the gums in many affined sugars, "gums" were not determined. The methods used for the

determination of the impurities will also be found at the conclusion of this paper. The figure  $C_1$  which gives a measure of the resistance to filtration by impurities is *inversely* proportional to the filtration rate of a sugar so that a sugar filtering well will be characterised by a small value of  $C_1$  and *vice versa*.

A number of sugars were exchanged with the Colonial Sugar Refining Company of Australia who also determined filtration rates on the sugars by a similar method. It must be mentioned that on these early tests no correction of pH was made, but subsequently on the advice of the C.S.R. pH's were corrected to 8.0 in order to approximate more nearly to refinery conditions. In Table A are given the results of these earlier tests showing also Australian filtration rates (expressed as a percentage of pure sucrose filtering under identical conditions). Although the Australians perform their filtration tests on sugar which has not been affined there appears to be a similar trend between their filtration rates and  $C_1$ . In Table A no significant correlation was found between phosphates and  $C_1$  while the correlation coefficient between starch and  $C_1$  was 0.72, giving a significance at the 2-5 per cent level. The correlation coefficient between silica and  $C_1$  was 0.924, being highly significant.

The results of tests on samples of sugar sent by mills towards the end of 1954 season are shown in Table B. Here again correlation between phosphate and  $C_1$  is not significant, correlation of starch and  $C_1$  has dropped to the 5-10 per cent ( $r = 0.48$ ) while that for silica is at the 1 per cent level ( $r = 0.74$ ).

To ascertain the efficiency of the filtration with respect to the removal of the impurities these were determined on seventeen sugar solutions both before and after filtration in the normal manner. The removal of starch by our filtration test varied from 23 per cent to 61 per cent, averaging 37 per cent, while that of silica varied from 0 to 47 per cent, averaging 22 per cent. Only seven of these sugars contained phosphate in excess of 10 p.p.m. and in their case phosphate removal averaged 84 per cent. The solubility of silica in a sugar solution under the conditions of the filtration test was found to be 85 to 90 p.p.m.<sup>2</sup> However, in sugars with initial silica contents lower than 85 p.p.m. some silica was still removed by filtration. This is probably due to the slow rate of dissolution of silica and several sugars examined have actually shown a slight increase in filtration rate on being held at 80°C for some time before filtration.

It was at first thought that starch might be removed during filtration by adsorption on the filteraid used but tests subsequently showed that although a small amount of starch is apparently adsorbed on the filteraid under the conditions of the test, it would be insufficient to account for 10 per cent of that actually removed by filtration in most cases. A solution of sugar which had its starch content reduced from 500 to 300 p.p.m. by filtration experienced a further drop to 250 p.p.m. on being filtered a second time.  $C_1$  for the initial filtration was 5.6 but dropped to 0.35 for the second filtration. This latter value is still somewhat short of that found for pure sucrose namely 0.12. It can be concluded that in spite of the brilliant appearance of the filtrate our pressure filtration is not 100 per cent efficient in the removal of impurities which can be removed by filtration.

Although the temperature of filtration is slightly higher than the melting point of cane wax, appreciable amounts of wax (chloroform extract) were found in filtercakes from our tests. After some initial difficulty in obtaining reproducible results it was decided to analyse sugars for this impurity rather than for phosphates. In Table C are given the results of analysis of sixteen A and B sugars composited over a fortnightly period by raw sugar mills in September 1956. Since all sugars analysed in connection with these tests were laboratory affined and any remaining impurities must have been concentrated mainly inside the crystal, some of the differences between A and B sugars are a little surprising. The correlation between starch and  $C_1$  is no longer significant in this series while that of silica is again significant at the 0.1 per cent level ( $r = 0.787$ ). The correlation obtained with wax is, however, even better with a coefficient 0.83.

The results of testing fifty-nine samples of sugar as exported in 1956 are shown in Table D. Correlation of  $C_1$  with starch is again not significant. That for  $C_1$  and silica is 0.75 and for wax 0.76. If all thirty-eight defecation mill samples are grouped together a correlation coefficient of 0.89 is obtained for  $C_1$  and the cube of wax values. The regression equation obtained is

$$C_1 = 0.74 + 0.93 w.$$

$$\text{where } w = \frac{\text{wax}^3}{1,000,000}$$

#### Discussion

That no correlation has been found between phosphate and  $C_1$  may be attributed partly to the fact that most of the sugars initially examined were from sulphitation mills and contained very little of this impurity. With the production of increasing amounts of defecation sugar it is possible that phosphates may be found to have a more pronounced effect than shown by these results.

In view of the varying percentages of starch removed by our filtration test it is perhaps not surprising that very little correlation has been found between starch and  $C_1$ . However, if one is prepared to accept that the presence of starch can affect the particle size of a precipitate of calcium carbonate formed in a sugar solution, it is not difficult to see that this impurity may have a marked effect on filtration in a refinery practising carbonatation. Unfortunately due to the difficulty in obtaining reproducible conditions several tests carried out at the S.M.R.I. to elucidate this point were inconclusive. It has been noticed, however, in the determination of wax that invariably when the aluminium phosphate filtered with great difficulty, the starch content of the sugar was high.

The correlation found between both silica and wax with the resistance to filtration is highly significant. Since the silica content of a number of sugars examined was less than the solubility of silica under the conditions of filtration the correlation of silica and  $C_1$  may possibly be due to the high degree of correlation between silica and wax. However, it is not known whether or not wax and silica are actually associated with one another in any way within the sugar crystal. The boiling of sugars from factory syrups at the S.M.R.I. has shown that those boiled in the laboratory are superior to those obtained under factory conditions with regard to filterability. However, as the number of variables in this type of work is so large it cannot be said as yet in what way the boiling conditions are likely to affect the inclusion of impurities in the sugar crystal resulting in poor filtration.

#### Conclusions

1. Phosphates in the sugars examined do not appear to affect filtration to any marked degree.
2. Although the degree of correlation between starch and the resistance to filtration in our tests is very low, it is not unlikely that this impurity may have a far more drastic effect when the filtering medium has to be precipitated in its presence.
3. It seems highly likely that wax and probably silica are among the more important impurities affecting the filtration of Natal raw sugars.

#### TEST AND ANALYTICAL PROCEDURES USED

##### Affination

A saturated sugar solution is prepared by adding an excess of sugar to the required amount of water and stirring with a mechanical stirrer for several hours. Care must be taken to control the temperature as solution of the sugar causes the temperature to fall below that of the surroundings. The excess of sugar crystal is removed by filtering through a No. 1

prosity sintered glass funnel. 1200 g. of the sugar to be tested is weighed into a gallon jar to which is added 1 litre of saturated sugar solution. The contents of the jar are then mingled for 30 minutes by rotation at 30 r.p.m., after which the magma is centrifuged in a laboratory type S.B. International centrifuge. Washing is carried out using 50 ml of cold water delivered in a fine jet from a specially constructed wash-bottle. After being allowed to air-dry in a thin layer the affined sugar is ready for tests.

#### Filtration Test

900 g. of the affined sugar and sufficient water (in our case 610 ml.) to ensure a final refractometric brix of  $60.0 \pm 0.3$  are mixed in a 500 ml. beaker until solution is complete. Calcium saccharate solution (usually about 1 ml.) is added to bring the pH of the solution at room temperature to 8.0 using a glass electrode. The solution is poured into a wide-mouth Erlenmeyer flask which is lightly stoppered to avoid evaporation and then heated to approx.  $82^{\circ}\text{C}$  on a water-bath. Standard laboratory filter-cell (0.35 per cent on brix) is then added and allowed to sink before the contents are mixed and poured into the "bomb," which is thermostatically maintained at  $80^{\circ}\text{C}$ . Agitation of the sugar solution and filteraid is achieved by both mechanical stirring in the bomb and by allowing air to bubble through at a controlled rate. After closing the bomb the pressure (from a compressed air cylinder) is raised by 10 lb. p.s.i. every minute until 50 lb. p.s.i. is attained, at which pressure the remainder of the test is run. The filter leaf, which is immersed vertically in the solution, is 1.5 ins. in diameter and the standard cloth used is clamped in position by a metal ring one-eighth of an inch deep so that the cake on being built up has this for support. The filtrate from the leaf is cooled in a condenser before being collected in a measuring cylinder. The first volume reading is taken after 5 minutes and further readings at 5-minute intervals until 35 minutes have elapsed, when the test is discontinued.

Plotting time against volume, the curve obtained approximates closely to that given by the equation

$$t = C_1 v^2 + C_2 v.$$

Where  $t$  = time

$v$  = volume of filtrate in time  $t$

$C_1$  = a constant which depends on the resistance to flow of the sugar solution due to suspended solids

$C_2$  = a constant involving resistance to flow due to constants of the apparatus.

$C_1$  is found by taking two pairs of values for  $t$  and  $v$  and substituting them in the equation  $t = C_1 v^2 + C_2 v$ , solving for  $C_1$ .

## DETERMINATION OF PHOSPHATES IN SUGAR

### Reagents

*Ammonium molybdate*: 15.0 g. ammonium molybdate are dissolved in 300 ml. water at  $50^{\circ}\text{C}$ . After cooling and filtering (if necessary) 350 ml. of 10 N HCl are added. The solution is cooled and made to 1 litre. It is stable for at least two months.

*Reducing Solution*: 90 g. sodium metabisulphite is dissolved in 800 ml. water. Anhydrous sodium sulphite (7 g.) and 1-amino-2-naphthol-4-sulphonic acid (1.5 g.) are dissolved in 100 ml. of water. The two solutions are mixed and diluted to 1 litre. The solution is stored under refrigeration in an amber glass bottle.

*Standard Phosphate Solution*: 0.7668 g. A.R. monopotassium phosphate is dissolved in water in a 1-litre volumetric flask to which is added 10 ml. sulphuric acid (S.G. 1.3) before the contents are made to mark. 1 ml. of this solution contains 0.4 mg.  $\text{P}_2\text{O}_5$  and keeps indefinitely.

### Procedure

25 g. of affined sugar are dissolved in water and made up to 200 ml. To an aliquot (20 ml.) of this solution in a 100 ml. volumetric flask is added 20.0 ml. of ammonium molybdate solution. After 2 minutes 10.0 ml. of the reducing agent is added and the intensity of the blue colour developed is measured on a suitable instrument after 5 minutes. The reading due to a blank with an equivalent amount of sugar solution but without the reducing agent is also made. This is subtracted from the previous reading and the value obtained read off from the standard graph prepared in the usual manner.

## DETERMINATION OF STARCH IN SUGAR

The colorimetric determination as described in the 1954 S.A.S.T.A. Proceedings was used.

## DETERMINATION OF SILICA IN SUGARS

Since a rapid method was required which would also be sensitive to the relatively small amounts of silica found in affined sugars the possibility of using the colorimetric method previously described in the *S.A. Sugar Journal*, September 1953, was considered. It was found that silica in sugar solutions could be made available for colorimetric determination by autoclaving the solution for 1 hour at  $125^{\circ}\text{C}$ . The sugar solution after cooling is made to volume, filtered and silica determined colorimetrically as described previously. Large aggregates of silica such as particles of sand etc. are of course not determined by this method.

### DETERMINATION OF WAX IN SUGARS

100 g. of sugar is dissolved in 100 ml. of water which is then heated to near boiling, and 2 ml. of 10 per cent potassium alum is added followed by 2 ml. of potassium dihydrogen phosphate and 4 g. of acid-washed kieselguhr. The mixture is allowed to stand overnight when it is filtered through a 5.5 cm. paper precoated with 1 g. of kieselguhr. After washing with water and drying at 100°C the paper and cake is extracted in a Soxhlet for at least 4 hours. The chloroform is evaporated and the weight of the residue multiplied by 10 to give wax in the sugar in mg./kg.

### SUMMARY

Results of filtration tests on a number of Natal raw sugars and their analysis for phosphates starch, silica and wax are given. No correlation was found

between phosphates and the resistance to filtration and little for starch, but the correlation with both silica and wax is significant. A description of methods used for analysis and tests are given.

### ACKNOWLEDGMENTS

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### REFERENCES

- <sup>1</sup> Cummins, A. B., and Weymouth, L. E. (1942). Filtration of Sugar Solutions. Ind. Eng. Chem., Vol. 34.
- <sup>2</sup> Poynton, M., and Alexander, J. B. (1957). Some Notes on the Solubility of Silica in Sugar Solutions. S.M.R.I. Quart. Bulletin, No. 1.

TABLE A

Results of Tests on Ten Natal Raw Sugar Samples Sent to Australia 1954

Sample	Australian Filtration Rate % on Unaffined Sugar	Starch before Affin. mg/kg	SiO <sub>2</sub> before Affin. mg/kg	P <sub>2</sub> O <sub>5</sub> before Affin. mg/kg	C <sub>1</sub> on Affined Sugar	Starch after Affin. mg/kg	SiO <sub>2</sub> after Affin. mg/kg	P <sub>2</sub> O <sub>5</sub> after Affin. mg/kg
TS 1954	2.4	720	260	21	5.49	750	163	10
FX 1954	6.7	370	260	—	3.81	340	127	15
MV 1954	13.8	540	161	24	2.08	540	58	5
TS 1953	16.4	610	170	20	2.04	560	85	5
DL 1954	17.4	340	163	8	1.42	310	54	4
UF 1954	31.7	370	225	18	1.82	320	100	3
RN 1954	33.1	410	116	—	Insufficient Sample for Analysis			
DL 1953	35.2	270	113	19	"	"	"	"
ZM 1953	36.5	230	118	8	0.84	240	32	6
IL 1954	52.3	360	128	15	0.96	340	23	2

TABLE B

Sample	C <sub>1</sub>	Starch mg/kg	SiO <sub>2</sub> mg/kg	P <sub>2</sub> O <sub>5</sub> mg/kg
ILL	0.55	280	42	8.0
FX	0.72	160	59	4.0
DL	0.73	225	49	2.8
DK	0.80	340	27	3.0
MV	0.86	260	48	3.2
ZM	0.89	200	31	2.2
ILB	1.00	340	51	10.8
FX 54c	1.11	210	88	4.2
SZ	1.17	340	28	2.4
TS	1.83	520	78	29.2
UF	1.89	400	80	2.4
AK	2.13	310	83	3.8
RN	3.93	500	65	3.6
EN	9.37	430	136	21.6

TABLE C

## Results of Test on A and B Sugars of September 1956

Sugar	C <sub>1</sub>	Silica mg/kg	Starch mg/kg	Wax mg/kg	Sugar	C <sub>1</sub>	Silica mg/kg	Starch mg/kg	Wax mg/kg
IL <sub>A</sub> ...	0.54	27	290	40	UF <sub>B</sub> ...	3.26	132	400	160
ZM <sub>A</sub> ...	0.58	49	260	30	ZM <sub>B</sub> ...	5.44	145	430	50
UF <sub>A</sub> ...	0.82	109	280	90	DL <sub>B</sub> ...	7.72	176	780	150
UK <sub>A</sub> ...	1.37	138	540	140	IL <sub>B</sub> ...	10.39	137	740	190
DL <sub>A</sub> ...	1.73	87	490	100	TS <sub>B</sub> ...	16.7	202	980	150
FX <sub>A</sub> ...	1.82	94	180	130	UK <sub>B</sub> ...	43.8	164	830	200
AK <sub>A</sub> ...	2.23	103	340	100	AK <sub>B</sub> ...	50.3	201	650	220
TS <sub>A</sub> ...	4.91	78	620	100	FX <sub>B</sub> ...	64.2	274	420	290
Average ...	1.75	86	375	91	Average ...	25.2	179	654	176

TABLE D

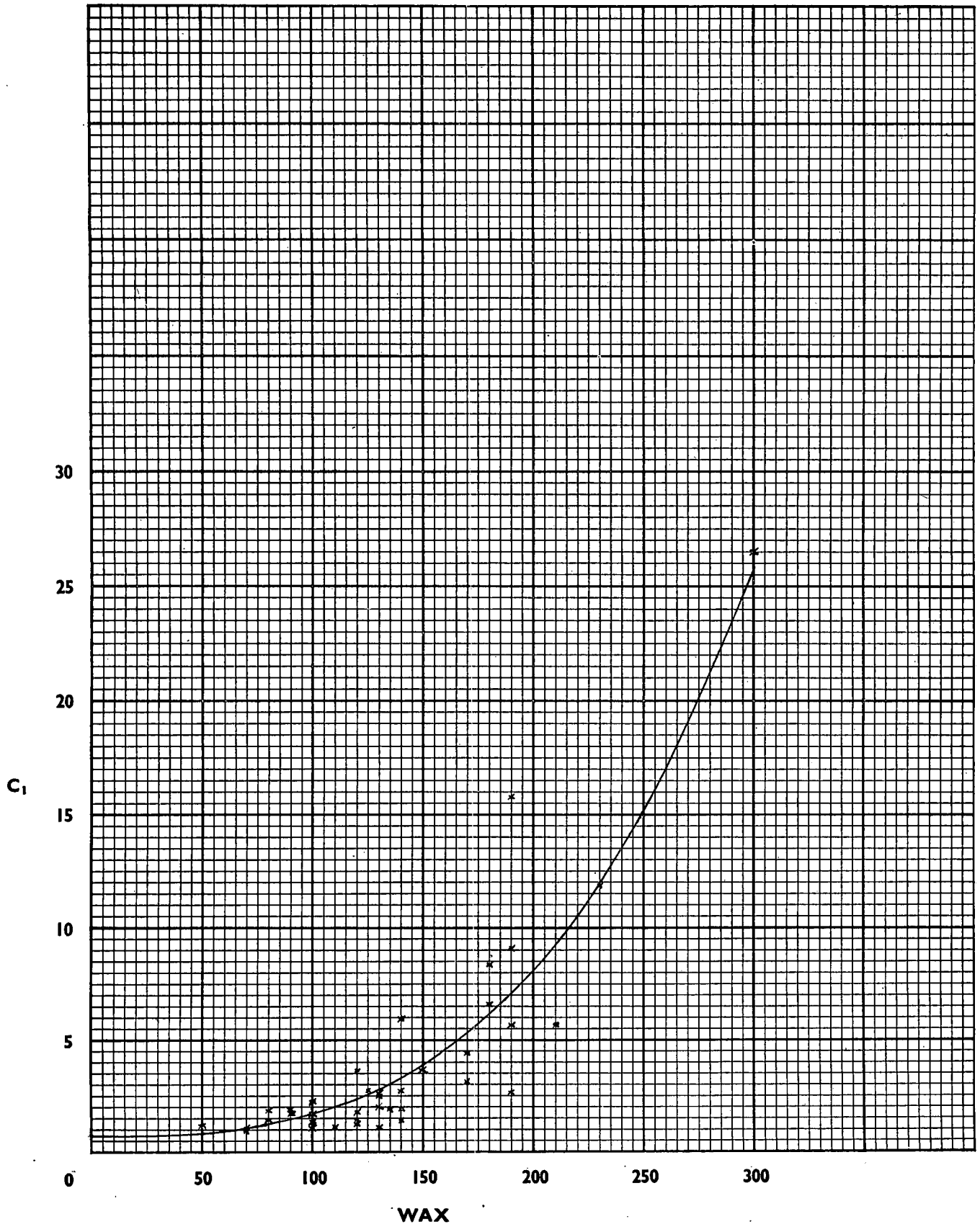
## Results of Tests on Export Sugars 1956

Mill	Date 1956	Silica mg/kg	Starch mg/kg	Wax mg/kg	C <sub>1</sub>	Mill	Date 1956	Silica mg/kg	Starch mg/kg	Wax mg/kg	C <sub>1</sub>
UF ...	6/8-11/8	103	300	120	1.23	G.S.E..	6/11-15/11	76	320	60	0.70
" ...	15/8-24/8	90	250	110	1.16	MV ...	6/8-11/8	25	260	70	1.04
" ...	6/9-12/9	94	290	130	1.10	" ...	20/10-31/10	44	220	100	1.34
" ...	14/9-24/9	101	250	100	1.06	" ...	3/12-13/12	48	290	70	0.98
" ...	25/9-2/10	71	350	120	1.75	TG ...	6/8-11/8	146	540	130	2.62
" ...	20/10-31/10	84	260	120	1.34	" ...	8/8-17/8	101	550	100	2.23
" ...	6/11-15/11	97	310	130	1.90	" ...	14/9-24/9	127	660	130	2.51
" ...	24/11-28/11	99	320	140	1.36	" ...	3/12-13/12	147	630	180	6.53
" ...	3/12-13/12	111	270	80	1.47	" ...	5/12-11/12	120	550	170	4.47
" ...	18/12-29/12	90	280	125	2.72	IL ...	6/8-11/8	58	410	100	1.70
FX ...	8/8-17/8	180	290	170	3.10	" ...	8/8-17/8	58	380	50	1.22
" ...	6/11-15/11	196	290	300	26.50	" ...	6/9-12/9	80	560	90	1.92
" ...	24/11-28/11	112	200	190	2.66	" ...	14/9-24/9	92	600	80	1.87
" ...	3/12-13/12	124	270	210	5.62	RN ...	6/8-11/8	79	340	50	1.83
" ...	8/12-29/12	154	240	230	11.81	" ...	8/8-17/8	131	480	80	3.13
EN ...	8/8-17/8	111	580	90	3.70	" ...	25/9-2/10	101	540	60	3.98
AK ...	8/8-17/8	115	410	120	3.71	" ...	6/11-15/11	122	430	70	4.17
" ...	5/12-11/12	115	430	180	8.40	SZ ...	6/8-11/8	64	420	40	0.77
DK ...	6/11-15/11	78	390	120	1.21	" ...	8/8-17/8	78	420	50	1.28
" ...	3/12-13/12	97	440	80	0.81	" ...	15/8-24/8	87	420	30	1.15
DL ...	6/8-11/8	75	430	90	1.71	" ...	6/9-12/9	131	580	40	2.59
" ...	8/8-17/8	73	430	100	1.36	" ...	14/9-24/9	90	460	50	1.51
" ...	6/9-12/9	121	560	130	2.00	" ...	25/9-2/10	99	530	40	2.04
" ...	2/9-2/10	64	600	140	2.73	" ...	20/10-31/10	53	420	80	1.06
" ...	6/11-15/11	131	630	190	9.03	" ...	6/11-15/11	78	450	40	1.36
" ...	5/12-11/12	164	690	190	15.80	" ...	24/11-28/11	81	460	50	1.83
GL ...	15/8-24/8	95	440	50	1.27	UK ...	6/8-11/8	108	530	140	5.99
" ...	6/9-12/9	146	630	60	1.09	" ...	15/8-24/8	124	500	150	3.61
" ...	20/10-31/10	132	530	70	3.19	" ...	6/9-12/9	134	710	190	7.57
" ...	6/11-15/11	110	460	40	2.78						

REGRESSION OF  $C_1$  ON WAX

$$C_1 = 0.74 + 0.93w$$

where  $w = \frac{\text{wax}^2}{10^6}$



**Dr. Douwes Dekker** (in the Chair) stated that this paper was a report on work done at the S.M.R.I. and is part of a wider programme of research to be carried out as a result of complaints about the quality of our raw sugars on the part of refiners. Other points which require investigation besides filtrability were the colour of our sugars and recently there have been complaints about the quality of our Government grade sugar.

**Mr. Rault** said that filtration efficiency was a very important factor in the running of a carbonatation process. So obsessed were they with smooth filtration that other requirements were sometimes not sufficiently checked and minimised, such as the destruction of reducing sugars, which was a direct result of filtration improvements. In South Africa more lime was used in cane juice carbonatation than in other countries. Previous tests from the S.M.R.I. showed that carbonatation sugars produced in this country were not free of starch, notwithstanding their excellent filtrability. He was pleased to note that it is now confirmed that this substance was not so detrimental to filtration, although it might cause difficulty in producing an adequate floc. Contrary to previous ideas, it was now reluctantly accepted that the poor, cloudy juices noticed at some factories working with simple defecation did not cause insuperable difficulty in the boiling house. He was still of the opinion that the clarity of the juice was of some value. Cloudiness might be caused by the presence of silica which may not be an obstacle to the recovery in a raw sugar factory, but depreciates the working quality of such sugars at the filtration stages of the refinery.

**Mr. Alexander** pointed out that any factory employing filtration and who carried out tests, should be sure that their test duplicated the practical refinery working as far as possible.

**Mr. Antonowitz** was impressed by the high correlation between the amount of silica present and the filtration rate. It was obvious that to get a good filtration rate it was necessary to have a very efficient clarification. He considered that the silica present was in the colloidal form and he thought that it was necessary to change this to the crystalline form. This could be done by the introduction of a chlorine ion.

**Mr. Alexander** said that at the S.M.R.I. they had come to the conclusion that silica was in three forms. Firstly as sand, then as silica in solution in the mixed juice, and then thirdly colloidal silica. This colloidal silica was present mainly in fine fragments of fibre and cell walls but due to the action of heat and lime raising the solubility of silica, more silica was found in a soluble form in clarified juice. On concentration, however, due to the solubility of silica in syrup being exceeded silica was thrown out of solution.

**Mr. Antonowitz** said that great stress should be placed upon those conditions under which silica could be prevented from going into solution. Therefore the juice should be kept at a lower pH before heating, and more attention should be paid to the pre-heating of the juice, bearing in mind the dangers of inversion.

**Mr. Alexander** said that even if the pH was kept low when pre-heating, eventually in the subsiders a high temperature was reached and the silica would go into solution.

**Mr. Antonowitz** said that colloidal silica presented a tremendous area to the juice, but if one could flocculate this in the early stages it would diminish the possibility of dispersing the colloidal silica in later stages. If those in charge of clarification in the sugar factories were made acquainted with the various reactions which take place a better quality sugar could be produced.

**Dr. Douwes Dekker** said that while he agreed with Mr. Antonowitz a great many factors were involved and he pointed out that under certain conditions the silica would be redissolved even if previously precipitated.

**Mr. Alexander** said that only the silica which had not dissolved could be precipitated in the mud.

**Mr. Du Toit** said that the high correlations found between silica and then wax on filtration would account for about 55 per cent of the total variation in filtration rates. He would like to know if partial correlation had been worked out because conditions created by one substance might affect the effect of another. He would like to know further how this figure "wax cubed" was arrived at.

**Mr. Alexander** said that as far as wax cubed was concerned this was worked out by the statistician on a matter of trial and error. Mr. Alexander said that the correlation between wax and silica in itself is not very high.

**Dr. McMartin** pointed out that one of the substances used by the cane plant in giving strength to its tissues was silica, especially in the leaves. He wondered if the introduction of trash into the sugar factory did therefore increase the amount of silica; perhaps also the variety of cane required in Natal promoted the production of a plant of high silica content. Comparisons of varieties under different growing conditions would be interesting and he asked if there were any information on this subject.

**Dr. Douwes Dekker** said that in other countries many determinations were made on the distribution of silica in various parts of the cane plant, but in South Africa as yet no such data had been accumulated.

**Mr. Boyes** commented on the poor results obtained from one factory and the high figures for wax, starch

and silica as compared with a factory nearby. He would like to know if anybody could advance reasons for such a disparity.

**Dr. Douwes Dekker** said that one had to differentiate between the amount of impurities present in the clarified juice and the amount which was included in the sugar. Very little was known about the laws governing the inclusion of impurities in the crystals during their formation. It was, however, conceivable that this mechanism was at least as important for the quality of raw sugar as the effect of the juice clarification process. In this respect he referred to the difference between the quality of sugars boiled in the factory in an ordinary pan and in the laboratory in a glass apparatus.

**Mr. Thumann** said that in the past it was customary to grain on syrup at Umfolozi. Now that C sugars

were used as footing it was possible that this C sugar had had most of its silica precipitated. By using syrup it was necessary to concentrate right down to get a minimum of mother liquor and it was possible that silica was then deposited and was included in the syrup boiled later.

**Dr. Douwes Dekker** said that this was another point which should be investigated.

**Mr. Rault** agreed with Mr. Antonowitz that the clarification of the juice was very important. In Natal carbonatation it was found that by heating the raw juice to a higher temperature much better filterability resulted. This might point to the fact of larger percentage of silica being precipitated in the early stages, before liming. He would be obliged if more investigation was done on this particular point.