THE DETERIORATION OF NATAL RAW SUGARS IN STORAGE

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Introduction.

Last year a report was made by the writer on the deterioration of the sugars held in storage at the Refinery during the 1935 Season. This, although originally intended solely as a routine laboratory report to the Refinery Management, showed that bigger losses had taken place than for four years previous, and that these were abnormally heavy in the case of deliveries from certain mills. As a consequence, the matter was brought to the attention of some of the Millers, and they requested that an investigation be made by the Technologists' Association. A committee was formed and a meeting held.

It must be realised from the outset that this is no "new" subject. The keeping properties of Natal Raws have been far from ideal since the beginning of the Industry, and for many years now checks and experiments on polarisation drop have been carried out at the Refinery Laboratory. Mr. L. Blacklock has submitted many comprehensive and useful reports, some of which may be found recorded in past proceedings of the S.A. Sugar Technologists' Association. We therefore have a great deal of significant local data already at hand, but the calling of a special Committee would indicate that this has been overlooked or forgotten, and it would perhaps be as well to recapitulate and summarise some of the previous findings and recommendations.

There is already a mass of literature on the subject of Raw Sugar Deterioration, and the experimental work on causes and effects has been so fully covered that it would be difficult to think of fresh lines of approach. In any case, the problem is now known to be largely a mycological one, and not easy to tackle from the point of view of research during the ordinary routine in a control Laboratory. Rather than attempting to unearth possible peculiarities in our own sugars under conditions which may give rise to errors in technique, it would be better to study fully and apply the results of the work of such authorities as Owen (1), the Kopeloffs (2), Church and Thom (3), Browne (4), Van der Bijl (5) and others. The work of Owen in particular has been so extensive and thorough that it is well nigh impossible to carry through any discussion on deterioration of sugar without quoting him freely, and in what follows the writer has taken this liberty. In fact, extracts from his most important papers (Published in book form by "Facts about Sugar" 1925) would in themselves form a very good presentation of the whole field of this highly important subject.

Experimental Work.

As has been stated, the certain prediction of the keeping properties of a sugar is not possible from a chemical analysis alone, but should be backed by some information regarding the degree of infection of the sugar with micro-organisms. Unfortunately we were not able to carry out any mycological work during the past season, but the analysis of sugars kept under various conditions will at least give an insight into the effects of the destructive forces at work. Previous experiments have shown that to keep samples of sugars in tins, bottles, small bags, etc., and do analysis before and after a certain period of time is absolutely worthless if a practical knowledge of the ability of a sugar to withstand storage in large stacks is being aimed at (6).

Consequently it was decided to work on batches of 10 bags (1.05 Tons) from the early season's deliveries from each mill. These 10 bag lots were sampled and analysed, then 5 bags were buried in a large stack of about 15,000 tons, and the remaining 5 bags kept outside the stack as a control.

After one month's storage it was found necessary to break down this large stack owing to the heavy exports by the Mills at that time, and the buried bags were then re-sampled and analysed. They remained stacked on their own for five weeks, and were then once more placed in the centre of another large stack of fresh sugar which was being built up. Here they stayed until their final removal after 7½ months storage, when they, and the 5 bags of the "outside" control, were again sampled and analysed. The results are given in Table 1.

It is immediately apparent that the behaviour of the "outside" bags is quite dissimilar to that of the same sugar when stored inside a large stack. In fact, the E.S.P. sample, which shows the biggest deterioration of all inside the stack, also shows the most rise in polarisation of the outside samples! In the majority of cases the C Sample shows a slight rise in pol. over the B, so it can be assumed that in the five week's interval when the bags were taken out of the stack, some drying out occured, even in sugars which had already begun to deteriorate.

The changes in polarisation and reducing sugar content may be summarised as follows:—

Mill	Inside Stack		Outside Stack	
	Pol.	R.S.	Pol.	R.S.
DL	—.25	+.06	—.30	+.07
AKL	—.05	+.08	+.10	—.04
UZA	—.10	+.06	+.10	—.02
DE	—1.85	+1.28	—.25	+.06
GS	—.35	+.04	+.10	—.03
TSC	—.45	+.10	—.60	+.06
ZSM	No change	—.06	+.05	+.06
ACF	—2.30	+1.16	—.25	+.01
CP	—1.05	+.91	—.05	+.09
RE	—.30	+.12	—.65	+.12
ESP	—3.70	+2.75	+.45	—.01

Three sugars show a bigger drop in pol. outside the stack than in. These are DL, TSC and RE. In the case of DL the difference is less than the experimental error and the two values may be taken as being the same. It is rather significant that in the 1935 experiment TSC was the only sugar to show a bigger drop outside the stack, no RE sugar being received in that year. On close visual inspection of sugars coming from the stack during the last couple of months of melting one could not help forming the opinion that TSC sugar showed by far the most signs of deterioration. Almost invariably the bags from stacks representing anything over six weeks storage were "sweaty" and damp, in marked contrast to the bags from most of the other mills. Yet on figures from these experiments it would appear that the TSC sugar did not show up so badly, ranking fifth in order of drop in pol. of inside sample. From the point of view of actual loss of sugar though, it must be borne in mind that a drop of .45 Pol. on the big quantity of TSC stored is of greater consequence than the more rapid deterioration of some of the other samples.

In most cases with the "inside" samples, a proportionate rise in reducing sugar content accompanies the fall in pol., but in the "outside" samples very little increase is shown. The ZSM sugar occupies a far better position regarding keeping quality than it did in the similar experiment carried out last year.

The period of total storage for the test bags—7½ months—is, of course, much longer than any of the actual stocks are kept at the Refinery. When deliveries are in excess of melting capacity, storage is arranged in such a way that on the mills resuming export the stocks can be worked through in order of arrival. In this way it is seldom that we have to handle a melt very much older than four months. However, even during this time it often happens that more serious deterioration takes place than is indicated by the test samples. With a view to getting some data on the behaviour of larger quantities of the different marks, another series of tests was carried out.

A record of the "Lot numbers" of bags going into the stack during certain periods was kept, together with their average analysis. On breaking down the stacks as many as possible of these same Lot Nos. were sampled and the analyses compared. Generally the samples range over 400-600 bags. Results are shown in Table 2.

We have now results which, although at variance in a few cases, in the main bear out the figures in Table 1. Allowing for the differences in the periods of storage, the heaviest deterioration is shown in DE2, ACF, TSC1 and 2, ZSM2, CP and NE. The last named was not included in the first experiment as sugars from this mill only came to hand during the latter part of the season, and were of such consistently high moisture that none were put in stock if it could be avoided. The ZSM sample shows deterioration whereas that in Expt. 1 did not.

The average drop in Pol., not taking into account the different quantities of the various marks, is 0.52. This is taken over the period when deterioration would be heaviest, and is probably fairly representative. On the whole season, with a melt of 136,638 Tons, the difference between average pol. of sugar received and melted is .14 This compares with previous years as follows:—

	Pol.	Red Sugar	Safety Factor
1936	—.14	+.13	.32
1935	—.19	+.11	.31
1934	—.05	+.08	.26
1933	—.17	+.13	.29
1932	—.12	+.10	.35
1931	—.34	+.27	.36

In the two months of January and February 1937, during which the greater part of 3-4 months stocks were melted, the average polarisation of the melt was 97.85 and 97.47, compared with the season's average of 98.15.

The influence of the lower polarisation of the sugar ex stocks may be shown by the following figures:—

	Tons Recd.	Av. Pol.	Total Melted	Av. Pol.	Tons ex stock	Av. Pol.
Jan. 1937.	6,405	98.15	14,614	97.85	8,209	97.37
Feb. 1937.	4,085	98.23	16,713	97.47	12,628	97.22

General Discussion.

Deterioration of raw sugars has been found to be affected by the following conditions:—

(1) The size and shape of the crystals. A sugar with small grains offers a greater surface to moisture absorption.

(2) The crystals should be coated with a film of Molasses of such high density and low purity as to preclude the growth of mold fungi. This is indicated by the "factor of safety" of the C.S.R. Co of $\frac{\text{Moisture}}{100-\text{Pol.}}$ =<F. where F is a ratio determined for the type of sugar being dealt with.

(3) For the good keeping properties of any sugar to be assured, it should have a minimum infection by micro-organisms, and particularly of the mold fungi type.

Dealing first with the mechanical condition of the crystal—Deterioration is essentially a problem connected with the outer covering, or molasses film, over the crystal, and it is only through the decomposition products of the former that the latter becomes involved at all (7). Yet naturally in the small grained sugar there is a bigger surface of this film exposed to changes in atmospheric conditions, infection, etc. Another point often overlooked is that with two massecuites of the same purity, one containing small and the other large grains, the former will almost invariably give a sugar of lower pol. than the latter, and to rectify this, "washing up" the small grain sugar will be resorted to. This alters the composition of the molasses film and hence induces deterioration.

In connection with the Safety Factor, and its applicability to Natal Sugars, we may quote Owen (8). "The factor of safety has been very thoroughly tested, and with certain modifications, the most essential of which is that Clerget or true sucrose shall be used for polarisation in the formula, and and that the ratio be four instead of three to one, it has been found to be entirely adequate as a criterion of the behaviour of sugars in storage. So much has been published regarding it that the term and its applications are very widely known, and employed throughout the entire sugar world, and there remain but few phases of it that are sufficiently novel to command interest."

So much then, for the Safety Factor in its wider aspects. At present, a moisture penalty is deducted from the price of all raw sugars received at the Refinery with a moisture content exceeding 1.05%. The time has come when this might well be superseded by a penalty scale drawn up on the Safety Factor. At the time of the inauguration of the total moisture penalty, this was regarded as some measure of protection against the sending in of sugars which it would be impossible to store without heavy losses from deterioration. Even with doubts in some cases of the validity of a Safety Factor, it is still a far better figure to use than total moisture.

There are instances where sugars with a low factor still deteriorate on storage, yet on full investigation these apparent inconsistencies are explainable. But there are very few cases in which a sugar with a high factor has been found to keep well. We know now that with a washed raw sugar the Safety Factor does not apply, though this important fact has very often been overlooked in the past. Again, it is the practice in many Natal Mills to mix away sugars from low grade massecuites with the higher pol. sugars. This cannot be too strongly condemned. It is bad on the score of SO_2 Content, filtrability and refinabiltiy, keeping quality, and of course gives one a false impression by the Safety Factor shown. The mixing of safe and unsafe crystals may give one a sugar that shows a good analysis, but in reality it is as much subject to deterioration as the most susceptible single crystal in the mixture; the Safety Factor in actuality applying only to each individual film, and hence being valid solely for homogeneous sugars.

The composition of the film itself determines its hygroscopicity. As the invert sugar content rises, so will a greater avidity for moisture be evidenced hence eventually bringing the sugar to the point where the ratio of moisture to non-sugar exceeds the figure below which micro-organic activity would be negligible. So a sugar must not only be dried at the outset to a definite moisture content depending on its purity, but must naturally not be subject to moisture conditions subsequently. At the Refinery the average relative humidity during the season was 73, and the stores are kept closed as far as is practicable, being opened only when the humidity drops to a figure of 60 or under.

The third, and perhaps finally the most important, point in connection with the keeping properties of a sugar is its degree of infection with micro-organisms. The micro-flora of sugars may be split into three groups:—

1. Mold Fungi.
2. Yeasts and torulae.
3. Bacteria.

Without going fully into the different species in these three groups that may be found, it may be stated now that the mold fungi are the organisms that do the damage (3). The bacteria are comparatively innocuous, in spite of what was previously believed. Not only are they unable to develop, except in the most dilute films, but their growth is almost completely inhibited by the acidity resulting from the action of the mold fungi.

The mold fungi cause rapid inversion of sucrose and are prevalent in most raw sugars, particularly where any dirty conditions prevail around the centrifugal, or bagging departments. They are very easily air-borne and can withstand a particularly severe dessication. Therefore, even an initially dry sugar must be kept dry, or the mold fungi become active. Then the vicious circle commences, and the increasing amounts of invert sugar caused through their activity encourage the absorption of further moisture. So it will be seen that the Safety Factor only holds for fresh sugars, and is invalid in the presence of incipient deterioration. It has been found that in some cases a sugar has kept well even with a high total micro-organic content, but this is almost solely due to the ability of the other organisms present to suppress the growth of the mold fungi (10). We are then led to the conclusion that the Safety Factor, useful as it is, cannot stand on its own in the foretelling of the behaviour of a sugar over a long period of time. A knowledge of the amount of mold infection is essential, and steps should be taken in Natal to provide facilities for such work. This is not a difficult or expensive matter, and is strongly advocated by Owen. In this way a good insight is obtained as to the sanitary conditions in, and around, the various mills. At this stage we might call attention to the practice of laying bagasse on the bottom of a truck before loading sugar. This bagasse invariably arrives at the Refinery in a highly fermenting condition, and the almost certain infection of the sugar is quite apparent.

The other group of micro-organisms—the torulae or yeasts,—are also fairly wide spread in their occurrence. However, it is now known that their actual invertive action is very small, if, indeed, they are capable of this destruction of sucrose at all; but they have a very interesting, and important, effect on the reducing sugars present. In almost all cases they show a selective action upon the fructose, and the consequent leaving of a preponderance of glucose in the invert sugar gives rise to an apparent increase in polarisation. Generally, a Clerget determination will show this up. But of course there are important results from this action. By removing some of the invert sugar, the sugar becomes less hygroscopic, or even loses moisture under conditions not really conducive to this phenomenon; and the products of the metabolism of the torulae, namely alcohol and carbon dioxide, are inimical to the rapid development of mold growths. It is on these principles that Owen recommends the actual innoculation of sugars with cultures of torulae to prevent their deterioration.

That torulae occur in Natal Sugars we know, and their action has been noted and commented upon in previous reports (11). They have shown their effect by a lower Clerget than direct Pol. more particularly in what have proved to be the better keeping raws. By their action they generally bring about a lightening in the colour of the sugar.

A really striking example of the deterioration which does occur in stacked sugars is demonstrated by the accompanying photographs. This type of decomposition is very common in nearly all the TSC deliveries, but is not marked in any of the sugars from other mills. It is noticeable only when the sugar has formed into a lump in the bag, and when such a large lump falls apart, the patchy appearance is very distinct. The white patches show the start of the infection and where the deterioration has proceeded to an advanced stage. The crystals here are soft and bleached owing to the acidity developed and the CO_2 evolved. The darkened ring shows the spread of the infection. This is not in such bad condition as the white portions, but the darkening indicates the rapid increase in reducing sugars and the activity of the mold fungi. The more neutral tinted portions show the colour of the original sugar, still comparatively unaffected.

In one picture a match box shows the size of the lumps. The three portions were separated as completely as possible and analysed as follows:—

A = White circular patches.
B = Darkened, syrupy rings round A.
C = Normal sugar.
D = Balance of lump on mixing.

	Pol.	Clerget Sucrose	Red Sugars	Moisture	Sucrose on Dry Basis Basis
A	87.55	88.39	6.48	3.30	91.41
B	91.70	92.08	3.41	2.38	94.32
C	97.90	97.97	.35	.54	98.50
D	95.25	95.54	1.92	1.06	

In splitting up these lumps it was remarkable that in about 70% of cases the white patch surrounded a small black particle of burned bagasse, this forming a core, as it were. It seems very likely that this air-borne particle carried the first infection.

Conclusions.

The conclusions from this report may be very briefly summarised:—

(1) Deterioration losses were still heavy in the 1936 Sugars.

(2) With few exceptions the heavy losses are localised to the same few mills as in previous years.

(3) Sugars with a high Safety Factor will not keep, and a penalty scale on these lines is desirable.

(4) Quantitative and qualitative control determinations of micro-organic infection should be adopted, and used in conjunction with the Safety Factor.

(5) Stricter measures should be taken at the Mills to ensure cleanliness in centrifugal and bagging departments.

Finally, this is purely a report on the deterioration question at is effects us, and nothing original is claimed for the views given.

REFERENCES.

(1) W. L. Owen, La. Exp. Sta. Bulletin 162.

(2) Kopeloff, Welcome & Kopeloff, La. Exp. Sta. Bulletins 170, 175.

(3) Church & Thom, La. Exp. Sta. Bulletins 162, 166.

(4) C. A. Browne, Jour. Ind. & Eng. Chem. 1918, 10, 3.

(5) P. A. van Der Bijl, Union of S. Africa, Dept. of Agric. Cc. Bulletins 12, 18.

(6) F. W. Hayes, Report on S.A. Raws, Proc. Int. Soc. S.C. Tech. 1935, p. 753. Also Report to S.A.S. Tech. Assn. on 1935 Raws.

(7) W. L. Owen, "The Deterioration of Raw Sugars in Storage." F.A.S. 1925. p. 7.

(8) Ibid.

(9) Ibid. p. 10.

(10) Ibid. p. 17.

(11) F. W. Hayes, Loc. Cit.

TABLE I.

A.—Original analysis of 10 bag lot.
B.—Analysis of stacked 5 bags after 1 month's storage.
C.—Analysis of stacked 5 bags after 5 week's standing, outside stack.
D.—Analysis of stacked 5 bags after *further* 21 weeks buried in stack.
E.—Analysis of control 5 bags kept outside stack at same time as D.

Mill.	Szample.	Pol.	Red Sugar.	Ash.	Moisture.	Safety factor.	SO_2 p.p.m.	Filter-ability
DL	A	98.85	0.17	0.22	0.32	0.28	53	—
	B	98.75	0.20	0.29	0.25	—	57	—
	C	98.85	0.21	0.28	0.20	—	—	—
	D	98.60	0.23	0.27	0.28	—	49	67
	E	98.55	0.24	0.30	0.29	—	50	65
AKL	A	98.50	0.27	0.31	0.32	0.21	63	—
	B	98.60	0.28	0.26	0.23	—	60	—
	C	98.60	0.26	0.26	0.22	—	—	—
	D	98.45	0.35	0.22	0.29	—	54	56
	E	98.60	0.23	0.27	0.22	—	52	49
UZA	A	99.00	0.15	0.22	0.32	0.32	69	—
	B	99.00	0.17	0.23	0.20	—	70	—
	C	99.00	0.16	0.22	0.20	—	—	—
	D	98.90	0.21	0.19	0.24	—	60	77
	E	99.10	0.13	0.20	0.13	—	57	79
DE	A	98.40	0.24	0.33	0.51	0.32	32	—
	B	97.80	0.42	0.33	0.62	—	40	—
	C	97.90	0.40	0.35	0.54	—	—	—
	D	96.55	1.52	0.34	0.88	—	44	66
	E	98.15	0.30	0.40	0.36	—	25	77
GS	A	98.65	0.19	0.30	0.26	0.19	60	—
	B	98.55	0.21	0.32	0.33	—	50	—
	C	98.65	0.23	0.32	0.28	—	—	—
	D	98.30	0.23	0.36	0.64	—	64	85
	E	98.75	0.16	0.29	0.17	—	60	85
TSC	A	98.60	0.14	0.46	0.36	0.26	80	—
	B	98.35	0.23	0.40	0.38	—	85	—
	C	98.40	0.22	0.43	0.31	—	—	—
	D	98.25	0.24	0.46	0.50	—	74	53
	E	98.00	0.20	0.60	0.25	—	88	47
ZSM	A	97.25	0.26	0.70	0.85	0.31	80	—
	B	97.00	0.26	0.68	0.69	—	76	—
	C	97.00	0.28	0.71	0.66	—	—	—
	D	97.25	0.20	0.73	0.58	—	72	29
	E	97.30	0.32	0.79	0.59	—	68	29
ACF	A	98.80	0.19	0.22	0.33	0.28	74	—
	B	98.40	0.29	0.28	0.43	—	56	—
	C	98.45	0.30	0.26	0.38	—	—	—
	D	96.50	1.35	0.30	0.78	—	59	56
	E	98.55	0.20	0.28	0.30	—	42	62
CP	A	98.25	0.18	0.40	0.59	0.34	64	—
	B	97.75	0.70	0.38	0.55	—	48	—
	C	97.65	0.76	0.40	0.53	—	—	—
	D	97.20	1.09	0.37	0.59	—	39	90
	E	98.20	0.27	0.39	0.46	—	40	95
RE	A	97.40	0.48	0.55	0.62	0.24	64	—
	B	97.30	0.50	0.57	0.60	—	65	—
	C	97.25	0.52	0.55	0.58	—	—	—
	D	97.10	0.60	0.61	0.63	—	66	43
	E	96.75	0.62	0.57	0.74	—	61	38
ESP	A	96.95	0.49	0.50	1.31	0.43	68	—
	B	96.35	0.94	0.46	1.22	—	66	—
	C	96.40	0.90	0.46	1.08	—	—	—
	D	93.25	3.24	0.47	1.29	—	79	48
	E	97.40	0.48	0.50	0.69	—	49	27

TABLE II.

Mill.	Month of Delivery.	Time in Storage.	A=Before. B=After.	Pol.	Reducing Sugar.	Ash.	Moisture.	Safety factor.
DE.1	November	—	A	98.38	0.14	0.32	0.52	0.32
		4 weeks	B	98.30	0.16	0.36	0.37	—
DE.2	November	—	A	98.02	0.18	0.42	0.79	0.40
		12 weeks	B	96.50	1.43	0.38	0.86	—
ACF.	November	—	A	98.60	0.18	0.26	0.40	0.29
		9 weeks	B	97.75	0.96	0.25	0.47	—
TSC.1	September	—	A	98.02	0.17	0.38	0.88	0.47
		15 weeks	B	97.45	0.82	0.39	0.65	—
TSC.2	September	—	A	98.02	0.17	0.38	0.88	0.47
		12 weeks	B	97.75	0.67	0.40	0.62	—
TSC.3	December	—	A	98.25	0.17	0.40	0.62	0.35
		3 weeks	B	98.15	0.26	0.38	0.60	—
ZSM.1	November	—	A	98—.21	0.15	0.42	0.60	0.34
		8 weeks	B	97.85	0.22	0.46	0.64	—
ZSM.2	September	—	A	98.32	0.14	0.39	0.65	0.39
		15 weeks	B	97.15	1.13	0.38	0.65	—
UZA.	November	—	A	98.62	0.12	0.35	0.36	0.26
		8 weeks	B	98.55	0.18	0.31	0.34	—
GS.	November	—	A	98.67	0.09	0.38	0.37	0.28
		8 weeks	B	98.45	0.21	0.30	0.36	—
CP.	November	—	A	98.50	0.06	0.35	0.59	0.39
		8 weeks	B	97.75	0.70	0.22	0.55	—
AKL.	September	—	A	98.63	0.12	0.29	0.40	0.29
		15 weeks	B	98.30	0.46	0.29	0.41	—
NE	December	—	A	97.70	0.19	0.55	0.91	0.40
		3 weeks	B	97.25	0.42	0.51	1.03	—

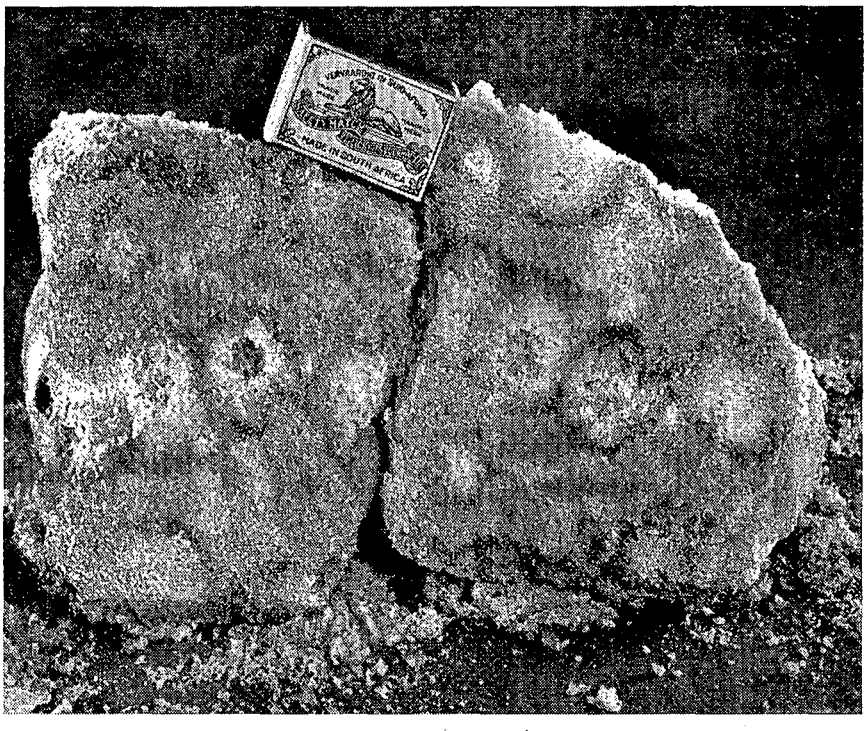

PLATE 1.

Lump of Deteriorated Sugar after 2½ months Storage.

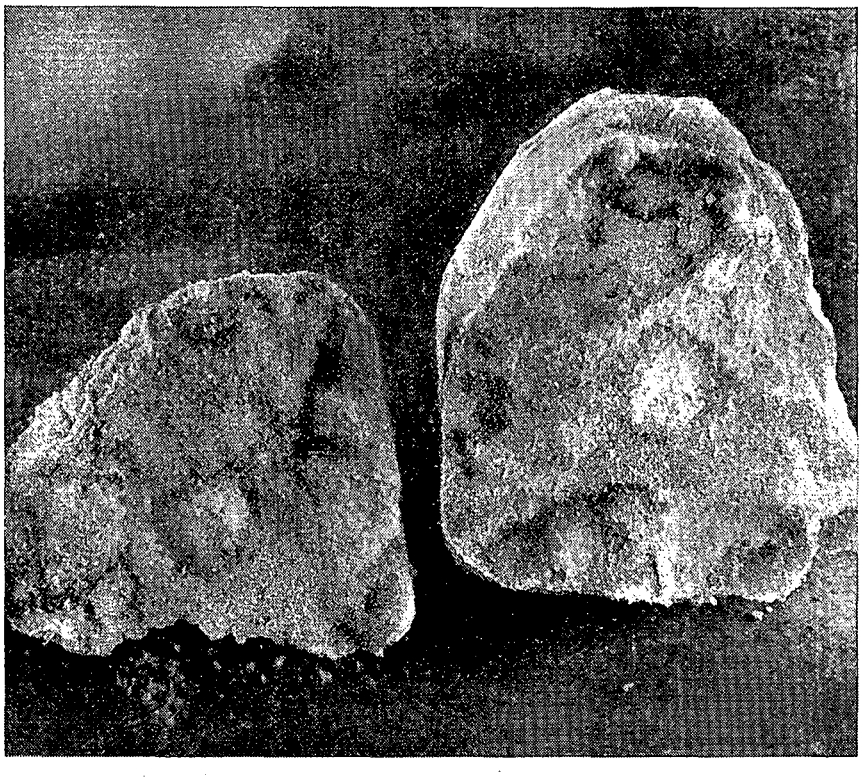

PLATE 2.

Lump of Deteriorated Sugar after 3 months Storage.

Mr. BLACKLOCK: Mr. Chairman, this is a paper which particularly affects the Refinery, and I would like to say a few words in amplification and support of Mr. Hayes. For the past ten years we have been conducting experiments in the comparative keeping qualities of Natal raw sugars, and also keeping statistical records of analyses of sugars as received at the Refinery, and again at the time of melting. A large amount of useful information has been accumulated, and from time to time extracts have been given at these meetings. Out of all this comes abundant proof that the most vital factor affecting the behaviour of a sugar during storage is the moisture content. It is true that this may be qualified by the extent of its contamination or infection by organisms such as moulds and yeasts, but a badly infected sugar will deteriorate even more rapidly when coupled with a higher moisture content. This was, of course, one of the reasons for the extensive use of the old moisture Penalty Scale, which, as Mr. Hayes has pointed out, has now become almost obsolete. This scale came into operation at 1.05%, but in these days of 97.5 to 99 polarization, sugars having a normal moisture content of 1% are almost impossible, and the maximum percentage allowable in order to ensure reasonable safety as regards deterioration is in effect much lower, varying indeed with the polarization and therefore also with the non-sugar content. This is the basis of the safety factor which has been discussed in the paper and considered by the Committee specially appointed for that purpose. Broadly speaking, the safety factor alone is a reliable guide in predicting the keeping quality of a sugar. Mr. Hayes has enlarged upon its limitations when applied to washed-up sugars, already deteriorated sugars, etc. Probably the time has now arrived when the old moisture scale should be superseded by a safety factor scale.

Further to the conclusions drawn by Mr. Hayes, two facts emerge from the work done in this connection: (1) a sufficiently dried sugar will "keep"; and (2) it is possible to make a raw sugar in Natal which will store for four or five months without appreciable loss in polarization. Over the whole of last season this average difference between the sugar as received and as melted worked out at 0.14%. This means that 190 tons of polarization which had been paid for at the average price had practically disappeared before entering the Refinery proper. This is not the end of the story, for the invert sugar produced would possibly prevent the realization as refined sugar of an equivalent amount of polarization, so that the overall recovery was depleted by some 380 tons, or a loss of revenue of nearly £7,000. The importance of the better drying of sugars, and strict attention to hygienic conditions at the mills is immediately apparent.

Mr. BECHARD: I welcome these papers, Mr. President. In past years we have had general reports about the bad quality of the sugars we were making. Unfortunately we did not know to what sugar it appplied. We all prided ourselves on our sugar. I am very pleased indeed that this paper has given the different marks of the sugar, so that if we are wrong we can remedy things, and if we are right we can let things carry on as they are.

Mr. RAULT: Mr. President, after listening to these papers, I am wondering whether the sugars which we have been exporting have also been deteriorating at the rate that is shown. I think some of us—or most of us—may have been surprised with the returns from sugar sent overseas. I would say that, to my surprise, most of the sugar that we exported from our firm did not fall on the right side of the safety factor, yet when we received our polarization from overseas, we found we had again, on the whole, received a different polarization that is not compensated for by loss in weight of sugar. So that possibly the conditions under which we are testing sugars are not quite the same as overseas. The amount we export overseas that drops in polarization causes a loss which has to be borne not by the Refinery, but by the raw sugar mills. Could anybody tell me whether there has been a big drop?

Mr. BECHARD: I think I can answer that to a certain extent. We have the results of our overseas polarization for the year before last. Our polarizaton increased by a matter of about 0.06 overseas and polarization increased between us and the Refinery about 0.14. But of course the time is rather different, and we have no idea of the loss of weight in export, although we know the weight received at the Refinery. The Refinery give us the actual return of sugar as received at the Refinery, and also polarization, whereas the figures received from overseas do not show loss of weight

Mr. COIGNET: May I ask Mr. Hayes whether the Refinery have, in their storage room, any devices to keep down the moisture of the atmosphere.

Mr. HAYES: There is no actual air-conditioning plant at the Refinery. The only precautions we are able to take at present are to keep the storeroom sealed as far as possible during damp weather. A careful daily check is taken of the humidity in various parts of the store, and we open up and air the stores thoroughly during dry weather. This, with heavy liming of the store, keeps the humidity down to a reasonably low figure.

Mr. Rault's reference to export sugar brings forward a rather interesting occurrence. Towards the end of last season it so happened that 4,000 tons of sugar, which it was originally intended to export, were deviated to the Refinery, and it was remarkable, in the case of some mills, how the quality of sugar that they were sending as export improved in comparison with local deliveries. It was not a general condition, but with some mills it

was very marked indeed; in fact, the two sugars were not recognisable as coming from the same factories at all. Facts like these may throw some light on the different keeping qualities of the export sugar and local sugar. There may also be differences in sampling methods. We overcome the difficulty of heterogeneous deliveries, as far as possible, by sampling every single bag as it enters the Refinery. This is not done overseas. Generally it is considered sufficient to sample a certain proportion of the total number of bags. From the very mixed nature of some of the sugars received, it will be realised that sometimes a difference will be found between two tests owing to lack of representation in samples.

Mr. MOBERLY: I would like to ask Mr. Blacklock if it would be in any way helpful for this Conference to give an expression of opinion, officially, that a penalty scale based on the safety factor is preferable to one based on the total moisture content?

Mr. BLACKLOCK: I think it would be quite a good thing if this meeting gave such an expression.

Mr. MOBERLY: I would like to move that in the opinion of this Association, a penalty scale for raw sugar payment based on the safety factor is preferable to one based on total moisture content.

Mr. BLACKLOCK: I support that.

The PRESIDENT: All agreed?

Mr. BECHARD: Do I understand that this goes forward as a recommendation of the Congress? I would like to take a vote on it for or against.

On a show of hands, the President declared "The Ayes have it."

Mr. RAULT: I would like to put a question to Mr. du Toit on the quality of the sugar. We are making a routine filtration test in our laboratory though it is not quite on the same lines as the Elliott Test. I must say that I was surprised to find that this year, in spite of crushing a larger percentage of the new variety canes, our cargo sugar did not show a higher filtration rate than we had the year before. So I would like to know, whether in your test there is any correlation between the percentage of new cane varieties and filtration rate, because one would expect for the new canes a much better working quality of juice, and there should be some decided improvement in refining quality?

Mr. du TOIT: I have pointed out that on the whole the filtration rate dropped quite a lot during the year under consideration as compared with the previous one. I also mentioned that factory No. 1 was the only factory that maintained a really high standard. By saying that, I mean that those sugars I got from them were really good, although a little inferior to that of the previous year. I also pointed out that in my opinion there is a correlation between the gum content and the filtrability, but I am not prepared to say that it is the result of the new canes that filtrability has dropped. Actually the amount of new varieties crushed during the year under consideration was but small and not likely to account for such a drop. And apart from that, we have no data whatsoever of the percentages of new canes as compared to Uba which were used in these sugars.

Mr. HAYES: I think you are all under a misapprehension as to the periods under review. The figures in Mr. du Toit's paper refer to the 1935 season—1935-36. The sugars received at the Refinery during that season showed a small drop in filtrability on the previous year. But from 1936/37 we show an increase of about 13% on 1935.

Mr. DODDS: I have always understood that there has been a definite improvement in quality in raw sugars during the past few years, although, perhaps, we have no definite analytical evidence for this. At all events, we hear less of complaints from overseas refineries. You may remember that a few years ago we had what might be described as a sulphur dioxide scare, and immediate enquiry had to be made. There was a Commission appointed from this Association, and Mr. Coghill, of the Experiment Station, contributed an excellent paper on the subject, and that matter appeared to be very largely settled. Since then, we have heard much fewer complaints about filtration and general refining qualities of our sugars. I think that we may take some credit for this Association for this improvement, because of the study that has been put into it and practical recommendation on the subject made by members in various papers and reports at our Annual Conferences, of which these papers by Mr. Hayes and Mr. du Toit are very worthy representatives.

Mr. RAULT: In asking a question about the correlation between the filtration rate and the increase in new cane varieties, my object is to show you that there is a lot of improvement that is being carried out in our Industry, improvement in technique, and there may be a tendency in the years to come to confuse the results obtained by this improvement in technique with the nature of the raw material from which we are starting. We cannot stop this improvement, but there is the danger of confusing the benefits obtained from the new variety canes with what would have been obtained without new variety canes but by our own improved technique. It would be rather difficult in years to come to separate the improvements realised by the two causes.

Mr. DODDS: In my opinion there already has been an improvement in the quality of our sugars as a result of improved manufacturing technique on sugar from Uba cane. I don't think we are in a position to say yet what will be the effect of the new canes, as far as qualities of resulting raw sugars are

concerned, but since we have been told that the colloid impurities of Uba cane find their way through to the refined sugar, it is reasonable to suppose that there will be a further improvement when we come on to the new canes, containing little or none of these colloid impurities

The PRESIDENT: I will ask you to join me in a vote of thanks to Mr. du Toit and Mr. Hayes for their valuable Reports.

(Applause).