

# KEEPING QUALITIES OF NATAL SUGAR.

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Further to my remarks under a similar heading submitted at a previous Conference, I take this opportunity of again introducing a subject dealing with a matter which concerns the whole Industry and is of vital interest to the Refinery.

The long-suffering and much-maligned Uba variety of cane, which for many years has been the only variety possible to cultivate with any success in Natal, has supplied us with a cane difficult to crush, a refractory juice difficult to clarify, and a raw sugar which is not easy to refine. In any case, Uba cane has placed South Africa on the sugar map of the world, and it is to the credit of the Natal sugar industry that these difficulties have been met and are gradually being surmounted. Our exported raw sugar has had an unenviable notoriety in past years—the difficulties incidental to its high colloid content probably precipitating the latent grouse which found concrete expression in the sulphur dioxide objection some three years ago. This point, as you know, was taken up and tackled successfully by this Association and the Mills, and the average SO<sub>2</sub> content of the export sugar to-day is in the region of 35 parts per million, whereas formerly a figure of 200 to 300 parts was not uncommon.

Cargo sugars from the mills have slowly and progressively improved in quality. Much higher polarisation and reduced SO<sub>2</sub> and other impurities are now the rule.

Raw sugars received at the Refinery during the past season have been, generally speaking, of good refining quality. Owing to the fact that all sugar goes to the refinery melt per medium of a 750-ton bin containing a more or less perfect mixture of several brands, it is very difficult, if not impossible, to make any definite statement regarding the practical refinability of one mark as against another. We can, however, compare them on a basis of their keeping qualities. Incidentally, I notice that H. D. Laurier, reading a paper on "Some Factors in Sugar Deterioration" before the Cuban technologists, recently claims to have established a definite relation between "keeping quality" and filterability. In any case the keeping quality of a sugar is of paramount importance. High polarisation, good colour, strong grain, all evidences of care and skill and time expended on the manufacture of a first-grade

article—all these are very considerably discounted if the "keeping" quality be not good also.

It may be argued that all these characteristics, including "good keeping quality," may be ineffectual if the place and conditions of storage are unfavourable. This is true, but under any given set of conditions it will be admitted that a sugar having the qualifications which make for good keeping will at all events hold its polarisation longer and be of a higher value when required. Deterioration will commence in any raw sugar with the lapse of time—the better keeping the sugar, the longer is this time extended limit. If by any effort or care on the part of the manufacturer this time could be fixed at, say, six months as a minimum under good storage conditions, then much will have been achieved and many thousands of pounds saved to the Industry.

During the past campaign it was perhaps fortunate that we were not called upon to store a large tonnage of sugar for such a protracted period, for the majority of mills sent out a product which, although of high polarisation and good appearance, showed decided deterioration at the end of two or three months. By attention to rotation of stocks and the selection, as far as practicable, when it became necessary to draw from stock, of the longest-stored sugar for melting, no portion of the accumulation of 23,000 tons, which was lying in our stores when the mills ceased delivering, had been lying in stacks for more than three months. This 23,000 tons comprised sugars from some twelve different mills, and each day a mixture of any or all of these passed over the debagging platforms to the charging bin. At this point traces of deterioration and sweating were easily observable in sugars issuing from the opened bags, and the differences in condition led to the taking of samples for analysis from each individual mark at intervals of two or three days. The results of these analyses, compared with the seasonal average of each sugar as arriving at the Refinery, is given in Table I.

In connection with this deterioration question, it has been our practice for some years to put aside and stack separately small lots of 10 bags of each mark. These were sampled at the time of stacking and again at the end of the season just before melting. The results of this test for 1931-1932 are given in Table II. below.

TABLE II.—SEASON 1931-1932.

10-BAG LOTS—STACKED SEPARATELY AND INDIVIDUALLY. ANALYSES BEFORE AND AFTER THREE MONTHS PERIOD.

Mark.	Date.	Pol.	Invert.	Ash.	Moist.	U.D.M.	Nett Titre.	P.P.M. SO <sub>2</sub> .	Safety factor.	pH.
<b>A</b>	Sept. 20	98.20	0.26	0.32	0.36	0.86	96.39	53	0.20	7.2
	Dec. 28	98.40	—	—	0.24	—	—	—	—	—
<b>B</b>	Sept. 20	97.40	0.66	0.30	0.62	1.02	95.34	24	0.24	6.8
	Dec. 28	97.10	—	—	0.73	—	—	—	—	—

TABLE II.—*continued.*

Mark.	Date.	Pol.	Invert.	Ash.	Moist.	U.D.M.	Nett Titre.	P.P.M. SO <sub>2</sub> .	Safety factor.	pH.
C	Sept. 20	98.10	0.27	0.36	0.52	0.75	96.08	38	0.27	6.8
	Dec. 28	98.15	—	—	0.38	—	—	—	—	—
D (1)	Sept. 20	98.55	0.16	0.29	0.22	0.78	96.99	38	0.15	6.8
	Dec. 28	98.65	—	—	0.25	—	—	—	—	—
D (2)	Sept. 20	97.85	0.26	0.41	0.44	1.04	95.64	56	0.21	6.8
	Dec. 28	98.35	—	—	0.36	—	—	—	—	—
E	Sept. 20	98.55	0.13	0.29	0.22	0.81	97.02	19	0.15	7.4
	Dec. 28	98.60	—	—	0.22	—	—	—	—	—
F	Sept. 20	98.00	0.21	0.52	0.28	0.99	95.34	94	0.14	7.1
	Dec. 28	97.70	—	—	0.30	—	—	—	—	—
G (1)	Sept. 20	98.85	0.18	0.19	0.19	0.59	97.72	56	0.17	7.0
	Dec. 28	99.00	—	—	0.15	—	—	—	—	—
G (2)	Sept. 20	97.40	0.43	0.55	0.62	1.00	94.32	80	0.24	6.8
	Dec. 28	97.90	—	—	0.42	—	—	—	—	—
H	Sept. 22	97.55	0.47	0.43	0.64	0.91	94.98	72	0.26	7.0
	Dec. 28	97.55	—	—	0.52	—	—	—	—	—
K	Sept. 22	98.00	0.32	0.36	0.52	0.80	95.98	60	0.26	7.1
	Dec. 28	98.10	—	—	0.40	—	—	—	—	—
O	Sept. 22	97.50	1.07	0.23	0.78	0.42	95.38	47	0.31	6.9
	Dec. 28	95.50	—	—	1.10	—	—	—	—	—
P	Sept. 22	97.85	0.21	0.50	0.68	0.76	95.24	38	0.32	6.9
	Dec. 28	97.90	—	—	0.66	—	—	—	—	—

Discussing the above groups of figures (Tables I. and II.), it is obvious that practically all the units embodied in the 23,000 tons block stack deteriorated to some extent. It is also evident that under exactly the same set of conditions two marks, "E" and "M," are very little affected and are much superior as regards keeping quality to the remaining ten. Mark "M" represented an exceptionally high grade and well manufactured raw, and although the tonnage sent was insignificant it was noticeably dry and in good condition after storage. On the other hand, mark "E" at all times contributes a large proportion of the Refinery's needs, and the free-running sugar issuing from these bags when opened for melting, confirms the analytical evidence of superiority shown in the above figures. Attention is drawn to the fact that both these sugars have a low "factor of safety"—both are hard grain sugars somewhat slow in dissolving, both yield clean solutions showing very little suspended matter. Putting it briefly, these are sugars resulting

from well-clarified juice and a carefully boiled masecuite and bagged reasonably dry from the centrifugals.

In direct contrast to these is mark "F", which constituted roughly 25 per cent. of the storage and was perhaps our worst keeping sugar this year. This mill managed to maintain a polarisation of 98° over the season as a basis for payment, but after two or three months' keeping it lost in degrees of value to the refiner anything from 1.1° to 3°. Over a tonnage of, say, 5,000 tons, then, this sugar would lose approximately 100 tons of polarisation and considerably more than that amount of recoverable refined sugar. The monetary loss involved is immediately apparent, and also the importance of "keeping quality" to the Industry as a whole.

That the storage conditions at the Refinery were good is perhaps one of the main inferences to be drawn from the results in respect of the 10-bag experimental lots, as shown in the second lot of figures. Generally

TABLE I.—SEASON 1931-1932.

CASUAL SAMPLES OF DIFFERENT MARKS TAKEN FROM STACK OF 23,000 TONS AFTER LYING IN STORAGE TWO TO THREE MONTHS.

Safety factor	A.			B.			C.			D.			E.			F.			G.			H.			K.			L.			M.			N.					
	0.32			0.44			0.36			0.31			0.28			0.37			0.28			0.40			0.34			0.41			0.16			0.44					
	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.	Pol.	Invert.	H <sub>2</sub> O.			
When received.	97.19	0.41	0.90	97.91	0.28	0.91	97.83	0.30	0.80	97.94	0.25	0.65	98.06	0.22	0.54	98.00	0.19	0.75	98.10	0.22	0.54	97.48	0.30	1.02	98.16	0.16	0.66	98.00	0.29	0.82	99.14	0.12	0.21	96.72	0.52	1.45			
Nov. 30 ..	97.55	0.30	0.72	96.70	1.10	0.84	97.50	0.45	0.70	—	—	—	97.15	0.35	0.68	96.90	0.83	0.74	94.65	2.81	1.22	96.40	0.88	1.25	97.40	0.83	0.40	—	—	—	—	—	—	—	—	—			
Dec. 9 ..	95.65	1.45	1.15	—	—	—	—	—	—	—	—	—	97.80	0.14	0.65	96.60	1.12	0.78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
.. 10 ..	97.10	0.42	0.94	96.45	1.35	1.12	97.50	0.35	0.83	—	—	—	98.00	0.16	0.68	96.05	1.42	1.27	—	—	—	97.00	0.83	1.28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.. 14 ..	97.15	0.34	0.87	97.65	0.49	0.54	—	—	—	—	—	—	97.35	0.44	0.75	96.60	1.08	0.78	—	—	—	96.80	1.04	0.72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.. 15 ..	96.35	0.45	1.06	97.35	0.58	0.62	—	—	—	—	—	—	97.40	0.50	0.68	96.90	0.54	0.86	—	—	—	96.55	1.43	0.88	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.. 16 ..	96.85	0.68	0.98	97.55	0.85	0.59	—	—	—	—	—	—	—	—	—	96.90	1.04	0.69	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.. 17 ..	—	—	—	—	—	—	95.90	1.73	0.95	—	—	—	97.90	0.14	0.47	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.. 21 ..	96.40	0.55	1.00	95.60	1.44	1.18	96.50	1.20	0.88	—	—	—	97.60	0.20	0.50	95.20	1.86	1.14	94.85	2.25	1.35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.. 22 ..	93.80	2.03	1.77	96.80	0.83	0.86	95.35	1.84	1.14	—	—	—	97.85	0.34	0.50	94.95	1.91	1.47	96.40	1.57	0.68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.. 24 ..	96.40	0.68	1.14	—	—	—	97.25	0.82	0.64	94.65	2.03	1.52	97.75	0.44	0.46	95.40	1.97	0.95	—	—	—	95.10	1.95	0.99	—	—	—	96.90	0.76	0.72	—	—	—	—	—	—	—	—	—
Jan. 1 ..	95.80	1.00	0.96	94.60	2.53	1.26	—	—	—	—	—	—	—	—	—	96.90	0.63	0.80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Dec. 31 ..	—	—	—	—	—	—	96.80	1.08	0.92	—	—	—	97.40	0.37	0.80	95.70	1.72	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Jan. 5 ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
.. 6 ..	96.25	1.06	0.81	95.50	1.84	1.14	97.70	0.70	0.38	—	—	—	96.85	1.24	0.63	95.50	1.65	1.10	—	—	—	97.65	0.36	0.067	97.35	0.90	0.46	—	—	—	—	—	—	—	—	—	—	—	—
.. 11 ..	96.70	0.37	0.82	96.20	1.36	0.82	95.75	1.21	0.90	—	—	—	97.00	0.50	0.78	95.35	1.57	0.84	—	—	—	94.10	0.89	2.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average when melted ..	96.34	0.78	1.02	96.44	1.24	0.90	96.70	1.04	0.81	94.65	2.03	1.52	97.50	0.40	0.63	96.08	1.33	0.76	95.30	2.21	1.08	96.23	1.05	1.11	97.37	0.86	0.43	96.90	0.76	0.72	99.00	0.24	0.32	95.90	1.40	1.40			
Physical characteristics :	Dark colour, soft grain. Dirty solution containing much insoluble and fine bagacillo.			Good colour, soft grain. Cloudy solution. Much very finely divided matter in suspension.			Good colour, hard grain. Clean solution. Very little suspended matter.			Fair colour, fairly hard. Dirty solution containing much matter in suspension in finely divided and colloidal state.			Darkish colour, hard grain. Clean solution. Suspended matter only slight and settles quickly.			Fair colour, softish grain. Dirty solution, large amount suspensoids.			Good colour, softish grain. Very clean solution. Should filter well.			Good colour. Fairly hard grain. Fairly clean solution. Little insoluble.			Fair colour, fairly hard. Dirty solution. Large amount finely divided suspended matter.			Fair colour, fairly hard. Clean solution.			Good colour, hard grain. Almost clear solution. Well manufactured sugar.			Fair colour, fairly hard. Dirty solution. Considerable insoluble.					

speaking these lots, by reason of the free circulation of air around them and the humidity control, seem actually to have dried out slightly with the result of holding or even raising their polarisation. The humidity control mentioned was dependent upon a comparison of the relative humidity inside the store with that registered by a hair hygrometer on an outside verandah. Normally the store was kept as tightly closed as possible, and was only opened up in respect of windows and doors at such times when the relative humidity outside was lower than that obtaining within. During the three months period of storage the average relative humidity was round about 85.8 per cent. and ranged from 66 per cent. to 96 per cent. There were about 18 days when the figure fell below 75 per cent. and the opening up on these days seemed to obviate any deterioration due to sweat developing in the sugar at the top or sides of the bulk stack as a result of atmospheric contact.

Of the small experimental lots, slight deterioration

was shown in the case of marks "B" and "F," and both these were markedly bad keeping when stored in the usual composite mass. Mark "O" absorbed moisture and went off badly—the other sugars having actually dried out under the same conditions. This is an example of a sugar with a safety factor in the danger zone, and one which gave a very dirty solution—cloudy with finely divided insoluble and colloidal matter—and therefore likely to be carrying mould, yeast and bacteria infection in a high degree. The value of the information gained from the small experiment is discounted by the fact that all these bags were taken from initial consignments from each mill, and therefore at a time when the product from the mill is usually first grade and sanitary conditions are at their best. It will be noted, for instance, that the safety factor all through is abnormally low.

Below are given the results of "keeping quality" experiment carried out on separate one-ton lots during previous seasons.

**TABLE III.—SEASON 1930-1931.**  
EXPERIMENTAL ONE-TON LOTS.

Mill.	Date of Sampling.	Months in Storage.	ANALYSIS.					Net Titre.	P.P.M. SO <sub>2</sub> .	Safety factor.	Keeping quality.
			Pol.	Inv. Sugar.	Ash.	Moist.	U.D.M.				
A.	June 5, 1930	6½	97.30	0.35	0.50	0.76	1.09	94.45	72	0.28	Good.
	Jan. 23, 1931		97.10	0.40	0.50	0.81	1.19	93.75			
B.	June 5, 1930	6½	98.15	0.20	0.26	0.45	0.94	96.60	55	0.24	Bad
	Jan. 23, 1931		96.50	1.20	0.27	0.79	1.24	94.10			
C.	June 6, 1930	6½	97.90	0.32	0.40	0.46	0.92	95.58	48	0.22	Good.
	Jan. 23, 1931		97.90	0.33	0.43	0.52	0.82	95.52			
D.	Sept. 29, 1930	4	96.75	0.78	0.35	0.82	1.30	94.22	80	0.25	Bad.
	Jan. 23, 1931		95.50	1.58	0.40	1.08	1.44	92.02			
E.	Sept. 10, 1930	4½	98.80	0.09	0.16	0.22	0.73	97.91	25	0.18	Good.
	Jan. 23, 1931		98.80	0.12	0.19	0.23	0.66	97.73			
F.	June 5, 1930	6½	98.20	0.19	0.39	0.43	0.79	96.06	90	0.24	Bad.
	Jan. 23, 1931		97.25	0.70	0.43	0.65	0.97	94.50			
G.	June 5, 1930	6½	98.95	0.14	0.20	0.22	0.49	97.81	120	0.21	Good.
	Jan. 23, 1931		98.75	0.21	0.22	0.30	0.52	97.59			
H.	May 25, 1930	8	95.65	0.84	0.51	1.48	1.42	92.26	150	0.34	Good. Simply dried out and became "safe."
	Jan. 23, 1931		95.95	0.97	0.57	1.13	1.38	92.18			
K.	Sept. 10, 1930	4½	97.00	0.32	0.66	0.96	1.33	93.38	85	0.32	Fairly good.
	Jan. 23, 1931		96.40	0.55	0.65	1.21	1.09	92.60			

The figures for season 1930-31 show that even over long periods varying from 4½ to 8 months, six sugars out of a total of nine showed no deterioration to speak of. Mark "E" gave excellent results as in 1931-32. Mark "H", a low grade raw, was unchanged except for loss of moisture, during a period of 8 months. In this case the sugar was put aside in May and evidently parted with some of its initial moisture to the dry atmosphere during the two following months and became safe. Marks "B" and "F" were again "bad keeping" as in 1931-32.

Going back still further to the season 1929-30, a slight variation in the usual trial lots experiment was made. 10 bags of each sugar were selected and sampled as usual—5 of these were stacked separately on the floor and the remaining 5 were given metal identification discs and buried haphazard in the interior of the main bulk stack. These were extracted 5 months later when the stack was pulled down, and they were sampled again and tested alongside the samples from the small floor stacks.

**TABLE IV.—SEASON 1929-1930.**  
KEEPING QUALITY EXPERIMENT ON SMALL LOTS.

Mill.	AUGUST 18, 1929. Sample from 10 Bags.					JANUARY 18, 1930. 5 Bags Buried in Stack.			JANUARY 19, 1930. 5 Bags Stacked Outside.		
	Pol.	Inv. Sugar.	H <sub>2</sub> O.	SO <sub>2</sub>	Safety factor.	Pol.	Inv. Sugar.	H <sub>2</sub> O.	Pol.	Inv. Sugar.	H <sub>2</sub> O.
<b>A</b>	99.05	0.05	0.15	61	0.15	98.50	0.15	0.26	98.95	0.13	0.19
<b>B</b>	98.55	0.17	0.27	32	0.19	97.95	0.43	0.49	98.35	0.40	0.24
<b>C</b>	97.90	0.25	0.52	45	0.28	96.10	1.24	0.82	97.20	0.80	0.54
<b>D</b>	97.80	0.23	0.63	63	0.29	97.90	0.25	0.49	97.70	0.50	0.48
<b>E</b>	98.45	0.12	0.39	60	0.25	96.55	1.52	0.68	97.00	1.17	0.59
<b>F</b>	99.00	0.10	0.14	175	0.14	98.20	0.47	0.30	98.10	0.54	0.36
<b>G</b>	98.65	0.13	0.36	30	0.26	95.30	1.72	1.24	94.10	2.50	1.39
<b>H</b>	98.15	0.20	0.42	54	0.24	98.15	0.38	0.41	95.00	2.29	1.16
<b>K</b>	97.30	0.22	0.75	75	0.28	97.35	0.40	0.40	97.00	0.58	0.79

This year it is seen that marks "A," "B," "D," "F" and "K" kept equally well whether inside or outside the stack, being all sugars with a good safety factor excepting "D," and this mark, like others in the succeeding seasons, managed to dry out somewhat and become "safe." Mark "C" deteriorated much more rapidly in the inside position and also took up more moisture there. The sugar was probably highly infected with micro-organisms and absorbed its moisture from damp sugars surrounding. The maintenance of a steady and somewhat increased temperature within the big stack would complete the conditions necessary for the development of invertive organisms. Marks "E" and "G" were both sugars of high polarisation and presumably had been "washed up" to some extent, the grain being left with a film covering of diluted molasses. This is a most dangerous type of sugar unless thoroughly dried and it deteriorated badly in both positions.

Enough has been said in the foregoing to bring out the inherent differences which obtain in the keeping power, and therefore the commercial value, of raw sugars made by some fifteen or sixteen Natal centrals all operating on a juice produced from the same variety of cane and working within a few miles of one another. The one outstanding fact which emerges from the above experiences is that it is possible to make a raw or cargo sugar which will, over a period of anything from two to eight months in good storage conditions, maintain its centrifugal polarisation and practically realise its original commercial value at the end of that time. Most of the mills appreciate the importance of sterilising and disinfecting mills, gutters, screens, and all portions of their internal anatomy, and the benefit accruing can be realised in the better working and increased yield of sugar and also in the increased re-ineability of that sugar; but it can be seen from the

foregoing that much of this care and skill and attention is wasted if the "keeping quality" of their final product is not also above reproach.

Apart from refining considerations in this country, attention must be drawn to the serious financial loss in respect of the large proportion of our crop which is exported and which is valued and paid for on the polarisation which remains on arrival at its destination, which may be months later than its time of manufacture. Experience suggests that to ensure a better keeping quality in our raws the following points are worthy of consideration and attention:—

- (1) Efficient juice clarification, giving the minimum of insoluble and suspended matter in the syrup boiled.
- (2) The production of a hard strong grain in the pans.
- (3) The thorough purging of the massecuite, leaving a residue of moisture in the sugar when bagged which will conform to a safety factor. Moisture divided by 100 minus pol = .25.
- (4) Strict attention to sanitary conditions at and around the centrifugals, filling bins and bagging rooms. Wash water when used should be sterile. Massecuite leaving the pans are sterile—infection of the sugar occurs subsequent to this.

CHAIRMAN: This paper is a very good example of what we might call "follow-up" work. Too often views are expressed on certain subjects which leave the matter somewhat in the air, and no more is heard of it; but Mr. Blacklock has followed up his work of previous years and kept us up to date with his latest findings. This is a very good practice for all those who bring new and old views before us, to let us know how they get on subsequently, and what further information they are able to give us from time to time. One thing occurs to me in reading this, and that is the safety factor, and the way it is referred to. It seems to me it would be better in referring to moisture per cent. net sucrose to refer to it as a danger factor, or take the reciprocal of it and call it the safety factor. In normal engineering practice a low factor of safety means danger and safety is obtained with a high factor. By using this safety factor in the way we do here we get the reverse.

Dr. HEDLEY: I wish I had seen this paper beforehand, because I came across a paper on the keeping powers of sugar in a certain volume. The book was Thaysen and Galloway's "Microbiology of Starch and Sugar." They showed a very interesting series of bacterial counts which were made to examine the bacteria infection from the crusher right away to the molasses. In the raw juice the concentration of bacteria runs into hundreds of thousands. On sulphiting the juice a certain amount of the bacteria are eliminated; clarification eliminates a great deal more. Then comes the boiled syrup before it goes into the pan, with a matter of perhaps two or three hundred bacteria per c.c. The sugar is discharged from the pan and goes into the

crystallisers, where in spite of the heating there are some hundred bacteria per c.c., and then finally goes through the centrifugals. There it is treated with unsterilised water and unsterilised air, and the bacterial contamination rises again to tens of thousands, and the sugar is stored with that large concentration of bacteria in the molasses which is attached to the sugar crystals. The molasses goes away, and in spite of the fact that molasses does not ferment of its own it is still highly infected and the bacterial infections in the molasses is in hundreds of thousands; so that you have a curve dropping to clarification and a curve rising in the same ratio to the final molasses, but the sugar goes away deeply infected. I think that possibly is the cause of the depreciation of sugars on storage, as these bacteria would bring about the inversion in the sugar. Indeed, Schone (*Zentrbl. f. Bakt.*, **17**, 563 (1907)), has shown that raw sugars contain many species of bacteria; he detected, in fact, 35 species in his work. It comes to the question, and it is one which in my mind is not yet definitely settled, as to how it is best to sterilise the mills and keep everything sterilised. I think some of you have used E.C. last season, and although a paper was read on it last year I do not feel that the question has been settled. There may be someone here who has had experience of it during the season, but it would look as if the air which rushes through the centrifugal should be sterilised, which could be done by using superheated steam, and sterilise the water which is being used to wash the crystals and also sterilise the molasses which are used to make up in the pan boiling.

Mr. BECHARD: What Mr. Blacklock has been reading to us and what Dr. Hedley has just said, have helped more or less to focus our ideas on the really unsatisfactory conditions ruling round centrifugals. I do not know if it is a design of Mr. Blacklock, but he gives strict attention to sanitary conditions around this point. Last year we had a paper from Mr. Moberly, Dr. Hedley and Mr. Beater, if I remember aright, about the suitability of Natal sugar for soft drink purposes. I mentioned one point had been left out, and that was the possibility of the sugar being affected by bacteria forming those rings under observation. I had good reasons to give that as my opinion, as I had the same difficulty once in Mauritius, where one of the prominent soft drink manufacturers found, with experiments carried out at the Experiment Station there, that the unsuitability of the sugar they were turning out at that time for soft drinks was caused by nothing else but a species of bacteria—a bacteria resisting high temperatures. This bacteria we know exists in sugar. I have done quite a lot of pathological work in the last two years. I might also mention I have done some experiments with E.C., and found that E.C., although it does reduce the set count, does not reduce it to any extent like ordinary formaldehyde. Formaldehyde has a value of at least a hundred times that of E.C. as far as reducing the bacterial count is concerned. This reducing of bacteria has much to do with the keeping qualities of sugar. The keeping qualities of sugar are largely dependent on the conditions round the centrifugals. Some of those conditions are unhygienic, to say the least

about them, and we find most of the pillars with constant dripping of solutions round them are porous, badly pitted and wet from the start of the season to the end. The smell is not generally to be recommended. I have not done any set count on sugar, but I am certain it would run well into hundreds of thousands in a great many samples of sugar. That is why I should say this condition that Mr. Blacklock makes under No. (4) in the end of his paper should be placed as No. (1). The next point is the question of the safety factor. Owen, who has probably done most work on that point, recommends a factor of 0.25, but he says that in sugar which has been washed the safety factor does not exist any longer. We know, since we have been determined on reducing the  $SO_2$  content, that a great many mills have gone in for washing sugars to reduce the  $SO_2$  content. To my mind washing of sugar is very dangerous and this safety factor of 0.25 does not apply. As Mr. Blacklock points out, this sugar without a film of molasses is dangerous.

Mr. RAULT: With reference to the definite relation between "filtrability" and keeping quality of sugars as expressed by the Cuban technologist, our experience is not quite in agreement with this statement. It is admitted that after the thorough clarification and four filtrations given to the juice by the carbonatation process at Mount Edgecombe, sugars from that mill will have a "filtrability" superior to that of the other sugars made in South African mills. Yet in spite of this advantage a batch of sugars from that mill deteriorated badly and, in fact, worse than previous experience had shown in other sugars. The cause of this deterioration was essentially an unfavourable water to non-sugar ratio at time of manufacture and a subsequent exposure to high relative humidity conditions during storage. We therefore believe that moisture content and atmospheric conditions are the prime factors in deterioration and not so much clarification or want of sanitation in manufacture. It is a physical impossibility to sterilise sugars completely during manufacture under factory conditions, but unless the film around the sugar crystal is dilute enough, either by washing the massecuite or by attracted moisture during storage, the organisms do not find a suitable medium for their development. It is the common experience of sugar technologists that exhausted molasses of a high density will keep for a long number of months, and will not invert and still less ferment. I should add, with reference to the carbonatation sugars, that since improving the water to non-sugar ratio, and also the conditions of storage, the trouble of deterioration has practically disappeared.

Mr. BLACKLOCK: I agree with Mr. Bechard when he says that concentration on the sanitary conditions at and around the centrifugals should have been mentioned first instead of last. I am afraid that I did not write the final recommendations in the strict order of their importance. I am certain that the question of infection of the sugar is an all-important one. To this end, Dr. Hedley has suggested sterilisation of the air. The organisms of mould and fungi, which are chiefly responsible for the bad keeping qualities of sugar, are nearly all air-borne, and although complete sterilisation is, of course, impossible, great improvements in this respect may be achieved by the liberal use of disinfectant in the vicinity. Washing sugar with infected water also increases the number of organisms taken up, and care should be exercised in this respect. Great improvements can be made by the use of superheated steam in place of water, or by following up the water wash with steam. It is true that certain bacteria are very resistant, but the main agents in deterioration—the fungi and moulds—are practically eliminated by the use of steam. From the work done with moulds by the Kopeloffs in Louisiana in 1920, it was concluded that with moisture ratios giving factor of safety of over 0.20 only 100 mould spores per gram were sufficient to cause deterioration, while with a drier sugar an infection of probably 100 times that number might be inactive. So that the keeping qualities of a sugar is really dependent upon the micro-organism infection considered in relation to the moisture content. Reduce the fungoid, yeast and bacterial infection of your centrifugaled sugar to the minimum by cleanliness, hygienic measures and disinfectant wash-downs—reduce your moisture content below the factor of safety limit as suggested, and the sugar will keep. The main point I wished to make in this paper is that one or two mills, by exercising this care, have succeeded in producing a raw sugar which will keep in good storage for six or seven months without serious loss of polarisation. Other mills, by falling into line, could therefore eliminate a very large seasonal loss to the Industry.

CHAIRMAN: I am sure we have to thank Mr. Blacklock very heartily for this paper and hope it will not be the last, and that he will continue his follow-up work. (Loud applause.)

At 12.50 p.m. the Congress was adjourned until 3 p.m., the Chairman reminding members of the Annual General Meeting to be held at 2.15 p.m.