EXPERIENCE WITH SODIUM HYDROSULPHITE AS AN AID IN SUGAR BOILING

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Abstract

Sodium hydrosulphite has been used in the sugar industry under the name Blankite, generally in the refinery as a decolorising agent. Very little has been written about the use of Blankite as a pan additive. Comprehensive trials with Blankite at three factories over a period of four years showed positive improvements in boiling time, exhaustion, centrifugal capacity, and final molasses purity.

Introduction

Sodium hydrosulphite, $Na_2 S_2 O_4$, the disodium salt of hydrosulphurous acid, possesses the ability to remove colour from raw sugar liquors by way of a twofold reduction reaction, involving hydrogen and sulphurous acid. The compound, known as Sodium Dithionite or Blankite, has for long been used as a decolorising agent in refined sugar production.

An extract from the "Java Archief" of June 1910[1] ascribes the earlier popularity of Blankite to astute advertising, insufficient knowledge of sulphitation technology, and the relative ease of treating syrup with Blankite to achieve the required colour reduction. The subsequent decline in interest in the product was attributed to the relatively higher cost, disagreeable sales techniques, and the absence of substantiating performance data.

West[2], reporting on experience in using Blankite between 1909 and 1910, mentions difficulties in C-curing two days after applying the chemical to A and B boilings. The poor performance was blamed on the Blankite addition as this was the only obvious change that had been made to the process. West admits, however, that certain items of plant were not ideal (long massecuite gutters, one crystalliser for two strikes), that there was no adverse effect on A or B curing, and that final molasses purity decreased by one unit. As the emphasis of process control at that time lay on throughput rather than recovery, West's disinterest in the product was perhaps understandable.

The author's interest in Blankite as a pan additive arose during the 1971-1972 season at Kilombero Sugar Factory in Tanzania where the chemical was used as a decolorising agent in refined strikes. Because of serious performance problems in terms of pan boiling times and in particular, centrifugal capacity, it was decided to try using Blankite in raw sugar boilings. Significant improvements in various performance areas were observed.

Further experiments were later carried out at two South African factories, Doornkop and Felixton, under very different conditions.

Procedure

Table 1 illustrates the main relevant process characteristics of the three factories at which experiments were conducted.

(a) *Kilombero:*

Due to adverse weather conditions which had a disastrous effect on cane quality, with mixed juice purities of less than 70 not uncommon, enormous problems were experienced with low grade boilings:-

1. poor crystal growth; elongated, conglomerated crystals
2. long boiling times
3. low final massecuite brix, a result of attempting to shorten striking times

TABLE 1

Comparison of Process Characteristics

Factory	Kilombero	Doornkop	Felixton
Season	1971/72	1974/75	1976/77
Raw juice clarification	Defecation	Defecation	Defecation
Refinery	Melt Sulphitation	Nil	Nil
Mixed juice purity	83,3	86,9	84,9
Final massecuite:-			
Brix	98,66	95,82	97,03
Purity	60,5	60,6	53,7
Cooling time (hrs)	22	24	96
Exhaustion %	65,4	63,3	53,2
Final molasses:-			
Apparent purity	34,6	36,1	35,2
True purity	40,3	38,0	38,7
At 85 brix % cane	4,06	3,26	3,34
Cane/Sugar ratio	9,57	8,57	9,55

4. massecuites overflowing the sides of the crystallisers due to frothing
5. very poor curing; centrifugal capacity decreased up to 80%
6. long mill stops through the factory being full
7. high determined and undetermined sucrose losses.

Blankite was used in a desperate attempt to save the factory from a complete shut down. The chemical was dosed as follows:-

A massecuites : 0,5 kg per 25m^3
B massecuites : 1,5 kg per 25m^3
C massecuites : 3 kg per 25m^3

Although comprehensive records were not kept, the following general observations were made following the dosing of Blankite.

1. improved crystal growth
2. reduced boiling times
3. higher and more constant massecuite brix
4. centrifugal capacity back to normal
5. factory stock reduced, no further mill stops
6. lower final molasses purity
7. improved factory performance with reduced losses

The results were sufficiently encouraging to warrant a more detailed investigation. In tests carried out between July and October, Blankite was added to A and B strikes just before graining, at the following dosage rates:-

Month	kg Blankite per A and B strike
July	Nil
August	1
September	0,5
October	Nil

(b) *Doornkop:*

Investigations were continued by the author at Doornkop. Unfortunately the mill was about to be closed down and very little time was available for the tests. Blankite was dosed only to the C massecuites, at the rate of 1 kg per 25m^3. The chemical was added just before graining. Average process results for the months of September, October, November 1974 were compared with those of the same months in 1973.

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(c) *Felixton: 1975/76*

Blankite was dosed at the rate of 1 kg per 25cm³ of C massecuite, with the chemical being added just prior to graining. Process results for the periods before, during, and immediately after the 3 week trial were compared.

(d) *Felixton: 1976/77*

Trials covered the whole crushing season. In total, there were 8 weeks (190 C strikes or 6 403m³ C massecuite) during which Blankite was not used and a further 8 weeks (200 C strikes or 6 898m³ C massecuite) during which Blankite was used.

The following data were recorded:-

1. *For each C strike*
   Boiling time
   Discharge time
   Delay time (waiting because of full crystallisers)
   Pol, brix, and purity
   Nutsch purities (when available)
   Massecuite volume
2. *From daily averages*
   Pol, brix, and purity of C massecuites
   Nutsch purities (at striking, after crystalliser, before curing)
   Total massecuite volume
   Purities of final molasses, C magma, C sugar
   Total discharge time
   Total delay time
   Total time A, B, C centrifugals stopped because of full molasses tanks
   General observations (slurry quantity, crystal size and quality, etc.).
3. *From weekly averages*
   Pol, brix, purity of C massecuite, final molasses, nutsch samples, C magma, C sugar.
   Total volume of massecuites boiled.
   Average boiling time.
   Average discharge time.
   Average delay time.
   Average time A, B, C, centrifugals stopped for molasses full.
   General remarks: slurry quantity.
   cane quantity.
   crystal size and quality.
   centrifugal capacity.

At Felixton, different purity levels and changes in the plant installed provided the opportunity to analyse and compare results obtained under various sets of conditions. The major differences are summarised in Table 2.

Further experimental details, contained in the summary of observations taken from the supervisors log book, have not been included in the paper but may be obtained from the author.

Results and Discussion

(a) *Kilombero* – see Table 3

TABLE 3
Results of Trials at Kilombero Sugar Factory

Dosage per strike		NIL	1kg Blankite	0,5kg Blankite	NIL
MONTHS		JULY	AUGUST	SEPT.	OCT.
A Strike	Bx. Pur.	92,22 85,1	91,78 85,7	91,52 85,7	91,59 85,3
A Molasses	Bx. Pur.	81,16 69,9	81,55 69,9	81,02 71,0	82,0 70,0
B Strike	Bx. Pur.	94,99 74,6	94,73 74,8	94,63 74,7	94,43 74,5
B Molasses	Bx. Pur.	85,74 56,0	86,59 55,5	85,95 56,7	85,69 56,6
D Strike	Bx. Pur.	98,24 60,2	98,95 60,2	98,78 60,3	98,20 60,6
Final Mol.	Bx. Pur.	95,20 33,79	94,07 32,57	94,13 32,92	92,52 34,01
Magma	Bx. Pur.	90,04 83,4	89,21 83,5	89,18 84,0	89,10 82,8
Yield	A B D	59,34 56,67 66,26	60,93 57,93 68,07	59,01 55,83 67,69	59,79 55,36 66,49

The following direct benefits resulted from the use of Blankite:-

1. Reduced viscosity of D massecuites which allowed a higher massecuite brix to be boiled.
2. Lower purity of final molasses.
3. Better pan exhaustion from improved boiling performance.
4. Higher molasses brixes as less water had to be sprayed on A and B centrifugals.
5. Higher magma purity.

(b) *Doornkop* – See Table 4

The results for Doornkop are comparisons between two seasons and suffer from the fact that 1974/75 was a drought year in which molasses results in Natal were generally very poor.

Despite the higher molasses % cane and lower boiling house recovery in 1974/75, there were definite indications of the benefits derived from the use of Blankite.

1. Improved exhaustion of C massecuites (September 2,21 units, October 2,05 units, November 1,43 units).
2. Improved target purity difference from 2,24 units in 1973/74 to 1,55 units in 1974/75.

(c) *Felixton*

The volume of data accumulated at Felixton is too great to be shown in any detail in this paper. Detailed results may be obtained from the author. The data were examined statistically to

TABLE 2
Installation and Operating Conditions at Felixton C – Station

Period	mℓ slurry per 65m³ C Massecuite	Purity C Massecuite	Crystalliser Capacity	Centrifugal Capacity
1975 Season	450	60	250m³	16 Batch Broadbents
May, June 1976	450	56	370m³	7 BMA Continuous
July 1976	450	54	370m³	As above
Aug.-Nov. 1976	up to 1 200	53	570m³	As above

TABLE 4
Doornkop Sugar Factory

	WITHOUT BLANKITE			WITH BLANKITE		
SEASON	1973/1974			1974/1975		
MONTH	September	October	November	September	October	November
True Purity	41,28	41,27	42,12	38,78	39,57	40,16
App. Purity	38,09	38,11	39,01	34,27	35,87	36,30
S.M.R.I. Target	+1,82	+2,29	+2,62	+0,76	+1,33	+2,57
Molasses % Cane	2,73	2,67	2,47	3,42	3,81	3,61
Red/Ash Ratio	1,06	1,12	1,09	1,25	1,42	1,32
Gravity Purity	39,14	39,18	40,05	36,78	38,02	38,36
Exhaustion	62,33	61,34	60,73	64,54	63,39	62,16
B.H.R.	92,19	91,80	92,00	91,61	90,39	90,20
Tons pol in final molasses % tons pol in mixed juice	6,75	6,97	6,47	7,66	9,12	8,86

TABLE 5
Felixton Sugar Factory 1976/77
Results of Statistical Analysis of Observations

Group	Control		Sodium Hydrosulphite				
	Ave.	Std. Dev.	Ave.	Std. Dev.	t-value	Degrees of Freedom	Level of Significance
Target purity difference	2,2	1,0	1,6	0,7	1,4	14	Not significant (Beyond 20%)
C-massecuite brix	95,36	1,05	95,65	1,00	2,87	342	Beyond 1%
C-massecuite boiling time	7,79	1,31	7,44	1,38	2,66	366	Beyond 1%
C-massecuite boiling time (corrected data)	6,98	1,18	6,53	1,16	3,96	348	Beyond 0,1%

determine the effect of Blankite addition on target purity difference, massecuite boiling time, and massecuite brix.

During the time that the trials were run in 1976 there was a consistent and statistically significant tendency for C-massecuite brix levels to rise. To remove this time effect before making comparisons between the control and experimental groups of results, the individual observation were corrected according to the slope of a brix/time curve drawn for the control data and the t-test applied to the corrected data.

The statistical results are shown in Table 5.

The following conclusions may be drawn from the statistical results:-

1. It may be concluded with only 80% certainty that Blankite treatment yields an improvement in target purity difference.
2. It may be concluded with at least 99% assurance that there was, on average, an increase of 0,3 units of massecuite brix through the addition of Blankite during boiling.
3. The analyses confirmed with better than 99% certainty that, on average, a decrease of between 0,4 and 0,5 hours in boiling time was possible through the addition of the chemical.

In addition to the statistically analysed results mentioned above, the following improvements through the use of Blankite at Felixton were observed:-

1. It was possible to boil lower purity C-massecuites when using Blankite.
2. Blankite addition produced a noticeable change in the rheological properties of the massecuites, which became, at equivalent concentration and temperature, much more fluid. This was a significant benefit at Felixton where an awkward gutter arrangement had resulted in delays in the boiling programme because discharged massecuites would not run freely to the crystallisers.
3. Improved exhaustion of all massecuites as the effect of the chemical circulated through the pan station.
4. Greatly improved C curing which resulted in the load on the factory being reduced to the extent that mill stops through "factory full," which plagued Felixton throughout most of the weeks when Blankite was not used, were reduced to a minimum and even eliminated altogether during the trial weeks. The improved curing was manifest not only in greater capacity per centrifugal but in improved forecured sugar quality and higher final molasses brix.

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2. Idem ... 896-897.