AN AUTOMATIC SYSTEM OF MILL SANITATION

By JEAN RAFFRAY

Abstract

An automatic system of mill sanitation using shockspray of a quaternary ammonium compound known as C.M.A. and a secondary mill sanitation during stoppages are discussed.

Introduction

The decomposition of sucrose due to micro-organism activities during milling and stoppages cannot be questioned. But investigators do not all agree on the extent of such decomposition.

Investigations carried out by Alexander and Van der Pol[1] and Bruijn[2] to determine the rate of deterioration of sucrose due to bacterial activity show losses from 0,23 to 0,26 per cent of the sucrose in cane. Other investigators have found losses 10 to 20 times higher. Thus a big discrepancy exists in the evaluation of these losses.

Sanitation in Natal Mills

Mill sanitation does not appear to be considered important in Natal factories where a survey has given the following information concerning the practice of sanitation in each mill:

1. No bactericide used — No washdown.
2. No bactericide used — Hot water washdown once per shift.
3. Chlorine at a dosage of 30 ppm is applied continuously to imbibition water and first imbibition juice.
4. Washdown with a mixture of steam and a bactericide once a week.
5. No bactericide used. Washdown with water at 65°C once per shift.
6. No bactericide used — No washdown.
7. Hot water washdown once per shift — Spray with chloride of lime once a week.
8. 200 litres of formaldehyde are poured in mill pits when reducing sugars ratio difference between mixed and crusher juice exceeds 0,5.
9. A QAC bactericide is used: 280 ml in imbibition water and 280 ml in last mill juice every hour — Washdown with hot water once per shift.
10. No bactericide used — Cold water washdown once per shift — Hot water washdown at weekend stop.
11. No bactericide used — No washdown.
12. No bactericide used — No washdown.
13. No bactericide used — Cold water washdown once per shift.
14. No. bactericide used — No washdown.
15. Spray of a solution containing 500 ml of a QAC bactericide in 20 litres of water once per shift — Hot water washdown once per shift.
16. Sanitation consists of killing cockroaches with a spray of insecticide solution once a week.
17. 500 g of a QAC bactericide added to last mill juice every hour — No washdown.
18. No bactericide used — Steam washdown once per shift.
19. 500 g of a QAC bactericide added to the water scale every hour — No washdown.
20. No bactericide used — Steam washdown once per shift.

According to this survey it cannot be said that the millers in Natal are enthusiastic about mill sanitation.

It is interesting to note that three mills add a QAC solution to the imbibition water and last mill juice. However, the benefit obtained from such a practice is doubtful because the strong attraction a QAC has for cane fibre suggests that most of the bactericide finds its way to the steam boilers with the bagasse.

It is not the intention of this short paper to establish why so little importance is given to mill sanitation in Natal factories. But it can be assumed that if new methods of calculating the sucrose content of cane are introduced, millers will make sure that they are not feeding bacteria with sucrose they have bought from the growers.

It is therefore expected that more thoughts will be given to an efficient mill sanitation in the future and with this in view, it is the object of this paper to submit to the millers a two-fold system of sanitation; one designed to operate during milling and the other to operate during stoppages.

Material and Technique

The basic principle of the first system is an automatic shock-spray of a quaternary ammonium bactericide to selected points of the milling train where the best use is made of the properties of QAC which are briefly summarised as follows:

(a) They are absorbed by the cellulosic material of the sugar cane or beetroot.
(b) They neutralise the acidic group of the bacteria and disturb its metabolism.
(c) They are bacteriostatic at a low concentration.
(d) They are stable within a wide range of temperature (0° - 100°C) and pH (3 - 10).
(e) They have wetting properties.
(f) They are soluble in water.
(g) They are non-corrosive.

The general layout of the system is shown in Fig. 4. The equipment consists of:

1. One Timer or Impulse Emitter.
2. Three 3 mm Solenoid Valves.
3. One 600 litre tank.

4. Piping, etc.

As shown in Fig. 4, three 6 mm diameter pipes each fitted to a 3 mm Solenoid Valve bring the solution from the tank to three points of application which are:

1. The shredded cane.
2. Mixed juice flowing from the mill.
3. Imbibition juice after 1st mill or 2nd mill.

The Timer is set so that it will energise and open each valve simultaneously for five minutes every 25 minutes. A shock-spray of six times the average daily dosage is therefore applied every half hour to each point.

The volume of each shock spray required is about four litres and this is approximately the volume which will flow through a 3 mm opening during five minutes so that the only adjustment required is that of the Timer. Total volume of solution sprayed per day is 4 × 48 × 3 or 576 litres.

The rate of flow through the valves will decrease slightly at each shock-spray as the level of liquid comes down in the tank but this inconvenience can be minimised by using a tank say 0,2 m high × 2 × 1,5 m with a volume of 600 litres.

Factory Tests

This automatic system of mill sanitation was evaluated in two sugar mills last year: (1) Umfolozi and (2) Tongaat.

Evaluation at Umfolozi

As a substitute to the usual mill sanitation at Umfolozi where chlorine at a dosage of 30 ppm is continuously applied to (a) imbibition water and (b) 1st imbibition juice, this automatic system consisting of shock-spray of a Quaternary Ammonium known as C.M.A. was put in operation on 27th September, 1970 on the new tandem.

However a shock-spray to the shredded cane as suggested was not found acceptable because it was feared that any addition of a solution to the cane prior to milling would not have met the approval of the planters. While this is perhaps a feeling of sucrose conjuring, calculation shows that four litres of a bactericide solution applied for five minutes to the shredded cane fed to this tandem at a rate of 160 tons per hour, is equivalent to a dilution of 1 : 3333 or 0,03%, which is well below analytical error obtaining in routine factory control.

The system of application was therefore modified as follows:

1. To the mixed juice.
2. To the 1st imbibition juice.
3. To the 2nd imbibition juice.

A four-week run was started on 27th September. During the first week a dosage of 5 ppm of C.M.A. was applied to clean the mills followed by three weeks at 4 ppm, 3½ ppm and 3 ppm respectively. This was followed by three weeks with the usual application of chlorine at 30 ppm.

Table I and Fig. 1 show the Reducing Sugars Ratio of Crusher and Mixed juice and also the Time Efficiency during both runs.

Compared to continuous dosage of chlorine, this shock-spray of C.M.A. showed a reduction of 0,14 in Reducing Sugars Ratio difference between crusher and mixed juice, at a dosage of 3,5 ppm.

When comparing the performance of two systems of mill sanitation it is important that time efficiency be the same in both evaluations because during stoppages micro-organism activity increases considerably resulting in an increase in Reducing Sugars Ratio of the mixed juice. Interpretation of the results may then be misleading. However this did not obtain during the tests as time efficiency was practically the same during both runs.

Evaluation at Tongaat

At Tongaat mill sanitation consists of spraying selected points of Tongaat and Maidstone tandems with a solution containing 500 ml of a QAC in 20 litres of water after hot water washdown once per shift.

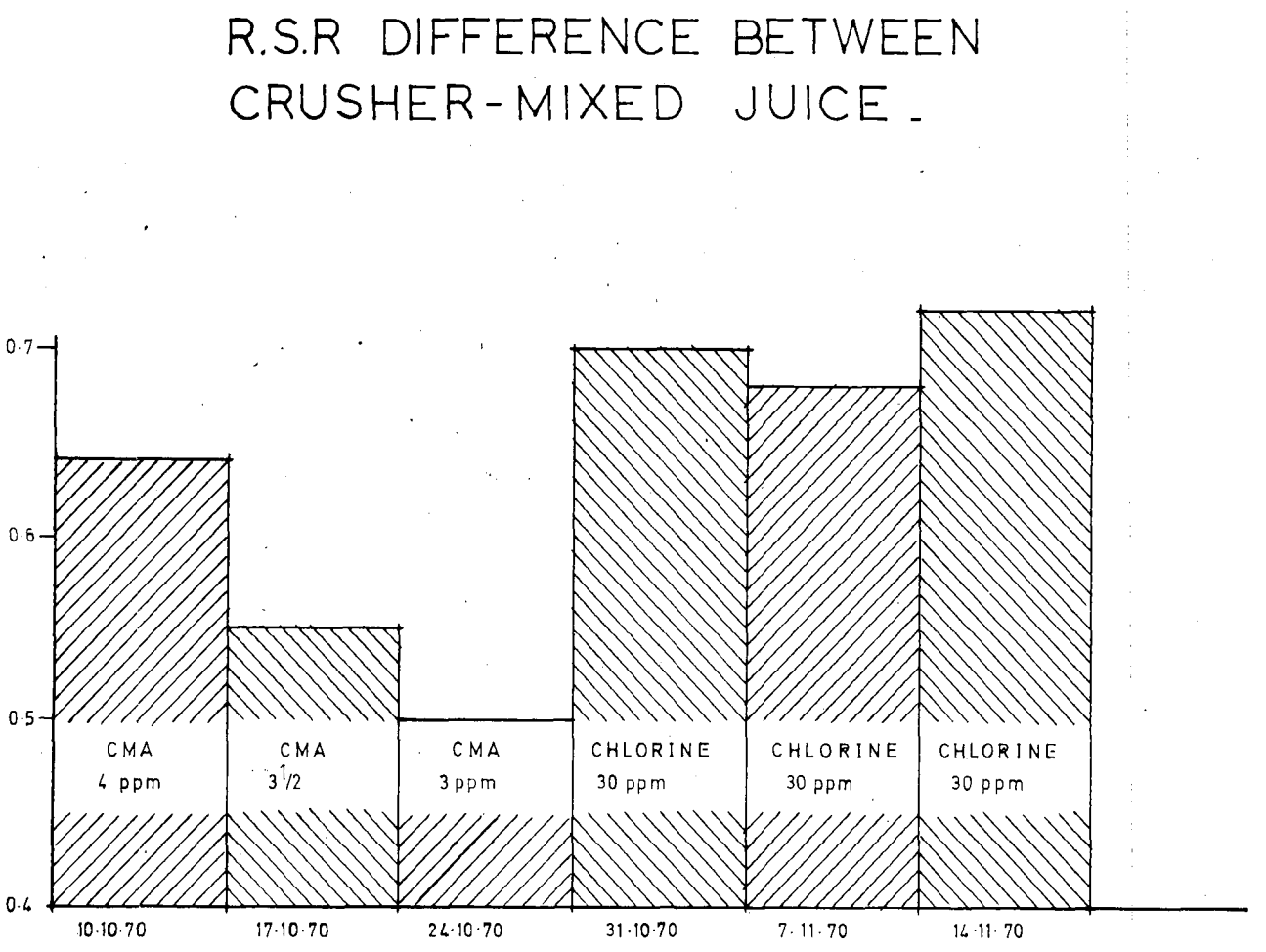
In addition to this routine sanitation, a three-week automatic shock-spray of C.M.A., similar to that applied at Umfolozi, was started on the Tongaat tandem on 3rd November, 1970, while no additional treatment was given to the Maidstone tandem.

A cleaning period of one week at 5 ppm was followed by three weeks at a dosage of 2½ ppm. Reducing Sugars Ratio of Crusher and Mixed juice was determined in both tandems and the results are

TABLE I

Week Ending	Sanitation Applied	Crusher Juice R.S.R. (a)	Mixed Juice R.S.R. (b)	(b) — (a)	Time Efficiency
3.10.70	5 ppm CMA	CLEANING PERIOD			
10.10.70	4 ppm CMA	2,46	3,10	0,64	96,4
17.10.70	3½ ppm CMA	2,56	3,07	0,55	95,1
24.10.70	3 ppm CMA	2,17	2,67	0,50	98,2
Average		2,38	2,94	0,56	96,6
31.10.70	Chlorine	2,44	3,14	0,70	96,1
7.11.70	30 ppm	2,98	3,66	0,68	95,1
14.11.70		3,06	3,78	0,72	95,0
Average		2,83	3,53	0,70	95,4

FIGURE 1



shown in Table II and Figure 2, which also show the Time Efficiency for both mills.

It must, however, be mentioned that during the first period from 3rd November to 13 November, 1970, the automatic system worked perfectly but during the second period from 14th November to 23rd November, 1970, mechanical trouble occurred resulting in an erratic application which affected the efficacy of the system. The RSR difference was only 0,06 lower in Tongaat tandem as compared to 0,20 during the first period. This was further aggravated by the low Time Efficiency of Tongaat mill which was 74,9% compared to 87,2% for the Maidstone tandem during that period.

Table III and Fig. 2 show the Crusher and Mixed juice purity and mill extraction during both runs.

A reduction in RSR difference between Crusher and Mixed juice should result in a parallel reduction in purity drop between these juices. But this is not always the case when mill extraction, quality of cane, load on rollers, etc., are not the same during the tests. As a matter of fact the purity drop criterion may be misleading and may show a better mill sanitation where there is no sanitation at all.

Sanitation During Stoppages

As already mentioned, considerable increase in bacterial activity occurs during stoppages and it follows that infestation of fresh juice will result in additional losses.

In an attempt to solve this problem, a secondary automatic shock-spray of a bactericide solution is suggested.

Figure 5 shows the set-up of the system which is designed to operate when the cane carrier is electrically driven but it can also be designed to function with a steam engine.

The system functions as follows:

When the starter (1) of the cane carrier motor is switched off, the Timer (2) is automatically switched on. The Timer then switches on the starter (3) of pump (4) which sprays the bactericide solution to selected points of the mill at recurring periods.

A time lag of five minutes is provided from the time the starter of cane carrier motor is switched off and the time the starter of the pump motor is switched on. This is to prevent the pump from operating during short stoppages due to overloading of cane knives, motor or chokes of the mills, etc.

FIGURE 2

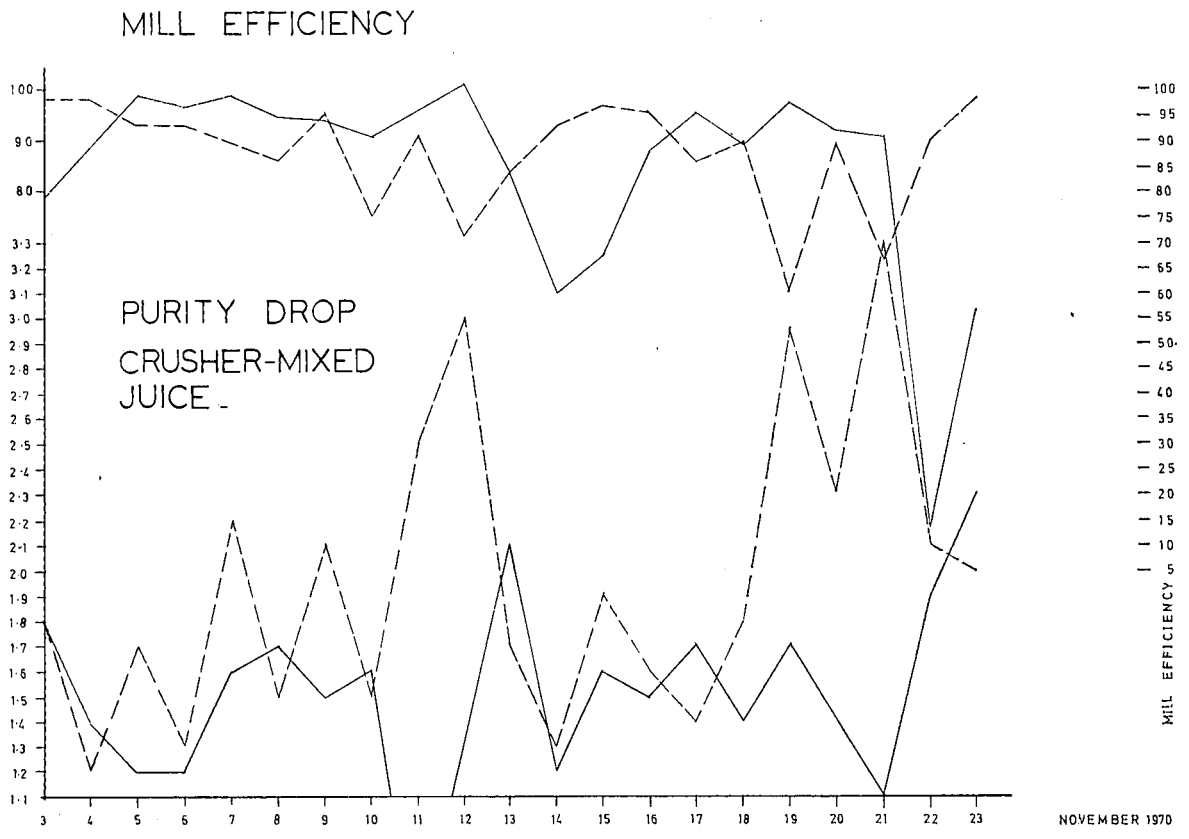
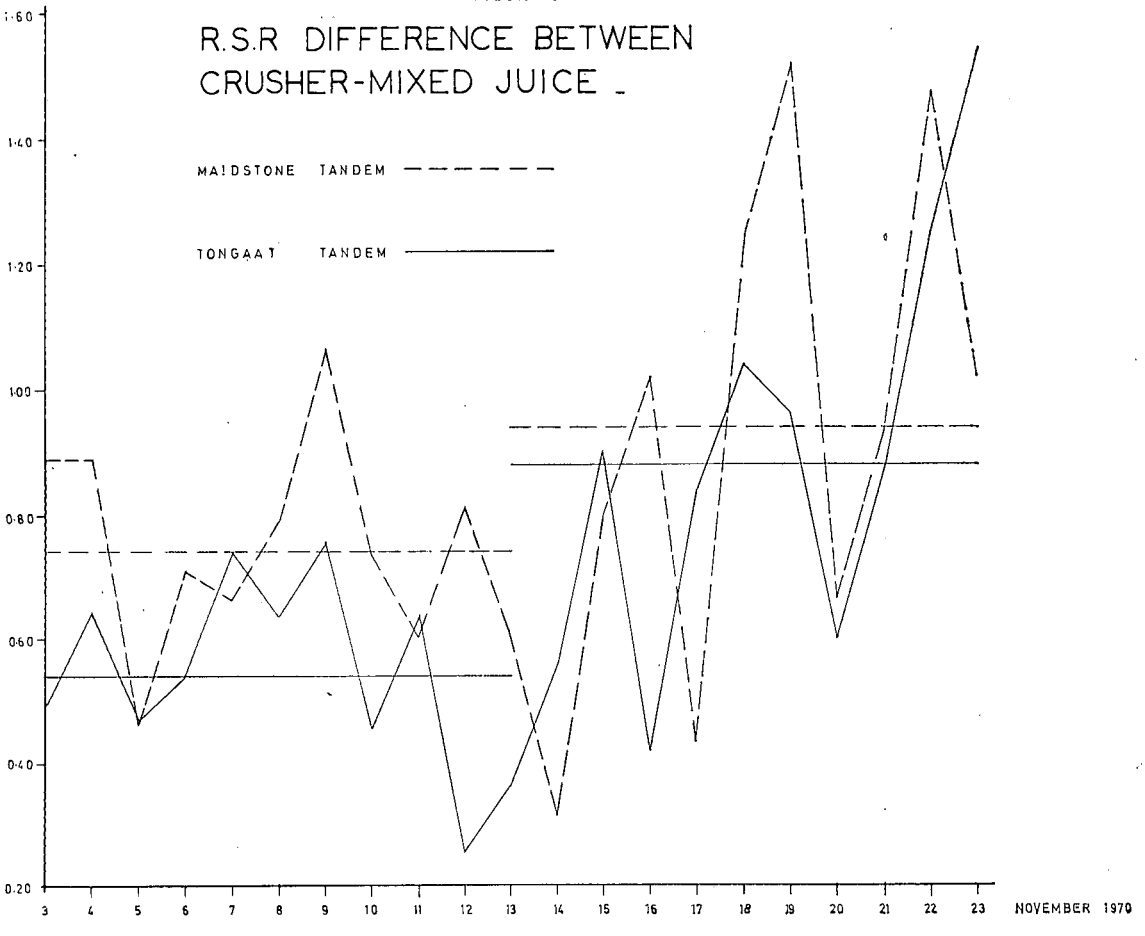


FIGURE 3



The pump starter is automatically switched off when the cane carrier starts again.

Discussion

An attempt has been made to solve the problem of sucrose decomposition during cane milling with an automatic shock-spray system at a low cost and requiring minimum attention.

The principle is based on the strong attraction of a QAC like C.M.A. for cane fibre and its bactericidal effect throughout the milling train as the juice is soaked and drained out of the bagasse at each successive mill.

The time during which the shock-spray is applied can be shortened or lengthened according to the number of units in the tandem.

In long mill tandems the time during which juice is recycled is longer and therefore the bactericide is present in the tandem during a longer period than in short tandems.

A longer shock-spray period would therefore be an advantage in short tandems and this can be achieved by using a smaller solenoid valve and adjusting the timer accordingly.

This system of automatic sanitation is also suggested for the diffusion process to decrease thermophylic bacteria activity. In this case shock-spray of the batericide could be applied to the bagasse entering the diffuser.

In an attempt to decrease bacterial activity during mill stoppages a secondary shock-spray of bactericide has been suggested.

Excluding weekend shut-down the average hours of stoppages in Natal factories during 1970 were 2,9 hours per day of which 1,5 were due to lack of cane and 1,4 to mechanical breakdown. Extremes were 0,2 and 4,4 hours for breakdown and 0,5 and 2,8 hours for lack of cane.

These figures indicate that the danger of losses during stoppages exists and that an investigation on the value of such a sanitation would be interesting.

Finally there is evidence that better juice quality, less viscous material to process and less molasses are the expected benefit of a systematic mill sanitation.

Acknowledgements

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TABLE II

Date	Tongaat Mill				Maidstone Mill			
	Crusher Juice R.S.R. (a)	Mixed Juice R.S.R. (b)	(b) — (a)	Mill Efficiency	Crusher Juice R.S.R. (a)	Mixed Juice R.S.R. (b)	(b) — (a)	Mill Efficiency
3.11.70	3,73	4,22	0,49	78,3	3,21	4,10	0,89	97,9
4.11.70	3,08	3,72	0,64	89,9	2,96	3,85	0,89	97,7
5.11.70	3,37	3,84	0,47	99,4	3,20	3,65	0,45	93,5
6.11.70	3,23	3,77	0,54	97,9	2,96	3,67	0,71	93,5
7.11.70	3,51	4,25	0,74	98,6	3,28	3,94	0,66	89,7
8.11.70	3,65	4,28	0,63	95,2	3,26	4,05	0,79	86,9
9.11.70	3,64	4,39	0,75	94,7	3,09	4,15	1,06	95,5
10.11.70	3,79	4,24	0,45	90,8	3,19	3,92	0,73	75,0
11.11.70	4,27	4,90	0,63	96,1	3,47	4,07	0,60	90,7
12.11.70	3,87	4,12	0,25	99,0	3,01	3,82	0,81	70,9
13.11.70	3,78	4,14	0,36	83,3	3,34	3,95	0,61	84,2
Average	3,63	4,17	0,54	93,0	3,18	3,92	0,74	88,7
14.11.70	3,78	4,34	0,56	61,0	3,57	3,88	0,31	93,3
15.11.70	3,77	4,67	0,90	67,0	3,32	4,11	0,79	97,2
16.11.70	4,02	4,44	0,42	88,5	3,23	4,25	1,02	95,3
17.11.70	4,58	5,41	0,83	95,8	3,77	4,20	0,43	85,9
18.11.70	4,11	5,15	1,04	87,8	3,90	4,63	1,23	88,9
19.11.70	3,70	4,66	0,96	98,8	3,10	4,62	1,52	61,8
20.11.70	3,77	4,37	0,60	92,4	3,48	4,14	0,66	89,9
21.11.70	3,99	4,86	0,87	90,4	3,43	4,37	0,94	66,2
22.11.70	3,53	4,78	1,25	10,8	3,16	4,63	1,47	90,3
23.11.70	3,35	4,89	1,54	56,9	3,65	4,65	1,02	93,5
Average	3,86	4,74	0,88	74,94	3,41	4,35	0,94	87,23
Overall Average	3,74	4,45	0,71	84,4	3,29	4,13	0,84	88,0

TABLE III

Date	Crusher Juice Purity		Mixed Juice Purity		Mill Extraction	
	Tongaat	Maidstone	Tongaat	Maidstone	Tongaat	Maidstone
3.11.70	86,1	86,3	84,3	84,5		
4.11.70	86,4	86,5	85,0	85,3		
5.11.70	85,8	86,3	84,6	84,6		
6.11.70	86,4	86,2	85,2	84,9		
7.11.70	85,8	86,1	84,2	83,9		
8.11.70	85,1	85,6	83,4	84,1		
9.11.70	84,2	86,0	82,7	83,9		
10.11.70	84,1	85,6	82,5	84,1		
11.11.70	81,0	84,1	80,6	81,6		
11.12.70	83,6	85,3	82,3	82,3		
13.11.70	84,5	85,4	82,4	83,7		
Average	84,8	85,8	83,4	83,9		
14.11.70	82,6	85,6	81,4	84,3		
15.11.70	84,3	85,3	82,7	83,4		
16.11.70	84,1	86,5	82,6	84,9		
17.11.70	83,9	85,2	82,2	83,8		
18.11.70	85,2	85,9	83,8	84,1		
19.11.70	86,5	86,6	84,8	83,7		
20.11.70	86,2	86,5	84,8	84,2		
21.11.70	84,2	86,1	83,1	82,8		
22.11.70	86,9	85,9	85,0	83,8		
23.11.70	85,7	85,1	83,4	83,1		
Average	85,0	85,9	83,4	83,8		
Overall Average	84,9	85,9	83,4	83,8	93,50	94,30

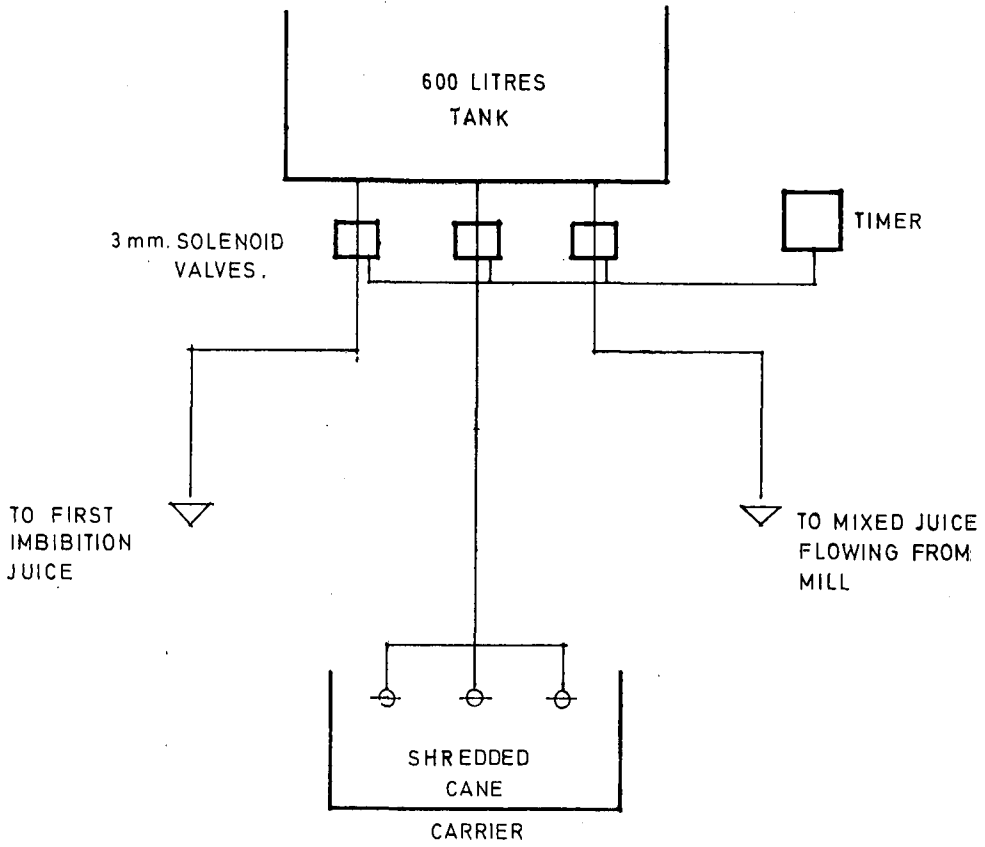
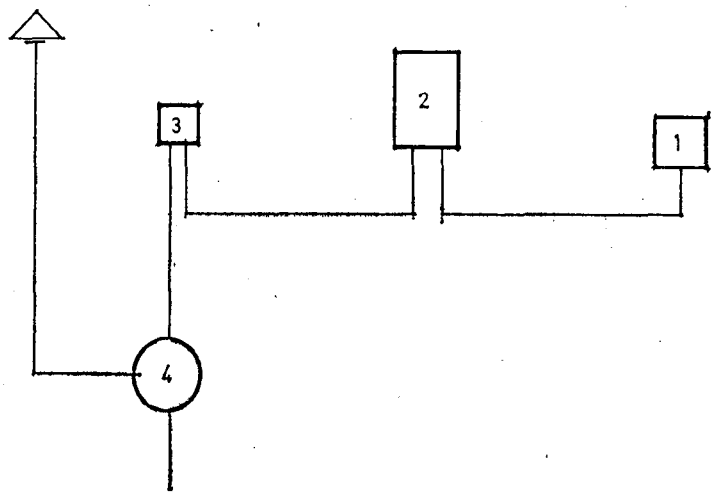


FIG. 4



1. STARTER OF CANE CARRIER MOTOR
2. TIMER
3. STARTER OF PUMP
4. PUMP

FIG. 5

Discussion

Mr. Gunn (in the chair): If there is a change in the system of evaluation of cane for payment purposes then sugar mills will have to devote more attention to mill sanitation.

It is difficult to assess the effects of mill sanitation. Tests at Tongaat were carried out on the small tandem which is subject anyway to the biggest changes in performance because of shortage of cane.

Dr. Matic: In the last paragraph the author says that with mill sanitation we can expect better juice quality, less viscous material and less molasses. This is most important but are there any figures to back this up?

Mr. Raffray: This type of sanitation is used in Madagascar, Reunion and Mauritius and it has been found that massecuites are less viscous and that there is a reduction in molasses per cent cane.

Mr. Carter: The importance of mill sanitation is only realised when trials are carried out. By using sanitation in our milling trains during the summer months we expected to show a profit of approximately R6 000, so we strongly recommend sanitation.

Mr. Hurter: Is it not so that QAC, if used in the milling train, will be present in the sugar produced and therefore can be regarded as a harmful additive?

Mr. Raffray: The FDA in America have approved the use of QAC and in France it is used in many industries, e.g. brewing, without any toxic effects.

Mr. Jennings: I quote from a paper by Bevan and Bond in the 1971 QSSCT Proceedings. "There are compounds on the market which if in sufficient quantity to process juices starting at the milling train would no doubt kill a great percentage of the microbial population, but these are expensive and would require constant application for effective treatment. Such a chemical must conform to the pure foods regulations regarding chemical addition, should not be excessively volatile, should be able to withstand the presence of organic material long enough to be effective, and should finally revert to a form which would have no deleterious effect on the final product. Biocides such as heavy metal salts, quaternary compounds, detergent-based biocides, highly volatile biocidal substances, and so on, would be either unacceptable or inefficient, so that a search for an ideal sterilizing agent which is economical enough to be used effective would appear to be most important".

Dr. Graham: The publication of someone's opinion does not mean that the materials available should not be tested to find the most suitable one.

Mr. Ashe: After using CMA for some weeks at Umfolozi the slime underneath the rollers disappeared completely and there was no smell at all.

Mr. Perk: Will Tongaat again be using QAC next year?

Mr. Gunn: It will be used in the summer months.

Mr. Ashe: Umfolozi will also use it on both mills.

Mr. Steffen: When using CMA do you still wash down with steam and water?

Mr. Raffray: It is good practice to wash down with steam or hot water once every eight hours.

Dr. Matic: Could not pH graphs be used to make comparisons between using sanitation and not using it?

Mr. Raffray: It might be a good criterion to measure the pH of the juice because if there is decomposition the pH will drop.