USE OF BIOCIDE TO IMPROVE MILL SANITATION

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INTRODUCTION

Effective mill sanitation is an important activity for sugar manufacturing process. Mill sanitation means keeping the mills sterile, because freshly extracted mill juice is infected with a number of microorganisms entering the mill through the soil which adheres to the cane. The extracted juice is an ideal medium for the growth and multiplication of these microorganisms particularly if the mill is not sterile. The most harmful bacteria to the sugar industry is leuconostoc mesenteroide (LM). It converts sucrose into glucose, fructose and dextran causing a direct loss of crystal sugar and resulting into products which interfere with the subsequent processes.

MILL SANITATION

Mills Sanitation can be discussed under two major headings

- Mechanical and physical cleaning of the mills
- Chemical Sanitation

MECHANICAL & PHYSICAL CLEANING OF MILLS

Mills sanitation has become a part of the routine work in the mills which arises because of

- Various leakages during the operation of the mills
- Excess oil and greases from the bearings plummer block get deposited on the pedestals
- Bagasse and bagacillo in the atmosphere gets deposited on the various parts of the milling plant
- Juice accumulation in the dead pockets

If this is not attended to, juice will remain stagnant & get fermented which leads to direct sugar loss

It is therefore, necessary to outline the activities or basic requirements of mechanical or physical mills cleaning for effective results.

- Frequent washing, cleaning and steaming in the mills at short intervals
- Bagasse accumulated in the various dead pockets ofmill head stocks be regularly removed
- The mills intercarrier, DSM screens / Rotary screensand juice tanks should be cleaned properly
- All the spillage should be washed as quickly as possible

CHEMICAL SANITATIONS

While regular physical cleaning of the mill help to reduce the accumulation, it does not prevent the growth of microorganisms in the warm cane juice.

The inversion of sucrose to glucose and fructose is influenced by these factors

- pH of juice
- Temperature of juice
- Retention time
- Presence of the enzyme invertase / microbial infection

GENERAL PROPERTIES REQUIRED TO BE USED FOR BIOCIDE

- Must have high antimicrobial activity
- It should be odourless, tasteless, safe and easy to handle at used concentration
- It should be non-toxic, stable over a wide range of pH & temperature
- Must be preferably cationic and compatible with most mineral salts contained in juices: sulphates, phosphates, carbonates & bicarbonates
- It should have a low use cost

REACTION MECHANISM

- It hydrolyzes to form hypochlorous and hydrochloric acid. The latter determines the biocidal activity. This process takes place according to the following reaction:

$$Cl_2 + H_2O \rightarrow HOCl + HCl$$

- HOCL is responsible for the oxidation reaction with cytoplasm of microorganisms, after diffusion through the cell walls, it disturbs the production of ATP (adenosine triphosphate), an essential compounds for the respiration of microorganisms

Formaldehyde

- Formaldehyde is found to be bactericidal during the initial growth period It inactivates the microorganisms by alkylating the amino and sulfhydral groups of proteins

Quaternary Ammonium based Biocide

- Causes disruption of intermolecular interaction of lipid bilayers
- Surface active chemicals with one nitrogen atom surrounded by substitutes containing 8-25 carbon atoms on four sites of nitrogen atom
- They are positively charged and bond to the negatively charged sites on the bacterial cell wall causing bacteria to die due to stresses in the cell walls

METHOD OF APPLICATION

- Biocide can be applied either shock dozing at the effected areas where microbial growth has already occurred or suspected to be started or it can also be applied continuously at chains, conveyers and last mill juice tank
- The shock dose of biocide is also more effective before crusher, at first two mills and at last mill juice tank
- In the shock addition, the total quantity of biocide required in one hour is applied within five minutes
- We need to emphasis that optimum results can only beobtained with chemical sanitation if regular housekeeping is practiced at the mills

BIOCIDE TRIAL AT SHAKARGANJ MILLS LIMITED, JHANG

- During the crushing season 2011-12, a trial of one month was taken. Keeping in view the variation in quality of sugarcane with passage of time, application of Biocide (x) was made at only one tandem and the results were compared with second tandem where bleaching powder and formalin were used in routine
- The comparison was based on rise in R.S per 100 Brix and difference of dextran level from primary juice to mixed juice
- A 15 days trial was taken at Tandem #1 of sugar mill from 19 Jan to 02 Feb. The dose of biocide (x) was kept 10 ppm as per recommendation of supplier
- Meanwhile, the use of bleaching powder and formalin remained continued at Tandem #2. Then a 15 day trial was also taken at Tandem #2 from 03 Feb to 17 Feb

RESULTS & DISCUSSION

The observations of the trial are tabulated in table 1 & 2 for Tandem # 1 and 2 respectively. The results of the 1st week addition of Biocide (x) are not taken for comparison due to prevailing effect of bleaching powder and formalin. Following observation took place

- From Table-1, Average rise in R.S per 100 Brix form primary juice to mixed juice was 0.67 at Tandem #1 and 0.77 at Tandem #2. Secondly, average rise in dextran at Tandem #1 was 1,580 ppm while at Tandem #2 it was 2,270 ppm.
- From the Table-2, average rise in R.S per 100 Brix form primary juice to mixed juice was 0.68 at Tandem #2 and 0.80 at Tandem # 1 and average rise in dextran at Tandem # 2 was 1,490 ppm while at Tandem #1 it was 2,095 ppm.

USE OF BIOCIDE (X) AT TANDEM # 1

TABLE # 1

Date	Primary juice				Mixed juice				Tandem #1	Tandem #2	Tandem #1	Tandem #2
	Tandem #1		Tandem #2		Tandem #1		Tandem #2					
	R.S / 100 Brix	Dextran (ppm)	R.S / 100 Brix	Dextran (ppm)	R.S / 100 Brix	Dextran (ppm)	R.S / 100 Brix	Dextran (ppm)	Rise in R.S / 100 Brix	Rise in R.S / 100 Brix	Rise in Dextran from Primary to Mixed Juice	Rise in Dextran from Primary to Mixed Juice
26 JAN	5.76	6,680	5.45	6,720	6.40	8,400	6.15	8,750	0.64	0.70	1,720	2,030
27 JAN	5.50	6,900	6.10	7,160	6.17	8,300	6.94	9,170	0.67	0.84	1,400	2,010
28 JAN	6.67	6,750	6.26	6,890	7.25	8,100	6.86	9,470	0.58	0.60	1,350	2,580
29 JAN	5.62	7,010	6.30	6,950	6.36	8,540	7.23	9,700	0.74	0.93	1,530	2,750
30 JAN	5.77	6,900	5.40	7,830	6.42	8,800	6.04	9,940	0.65	0.64	1,900	2,110
31 JAN	5.50	7,400	5.07	6,480	6.20	9,030	5.82	8,810	0.70	0.75	1,630	2,330
01 FEB	5.90	7,800	5.75	7,100	6.60	9.250	6.50	9,440	0.70	0.75	1,450	2,340
02 FEB	5.66	7,150	5.80	6,950	6.35	8,810	6.78	8,960	0.69	0.98	1,660	2,010
Average	5.80	7,074	5.77	7,010	6.47	8,654	6.54	9,280	0.67	0.77	1,580	2,270

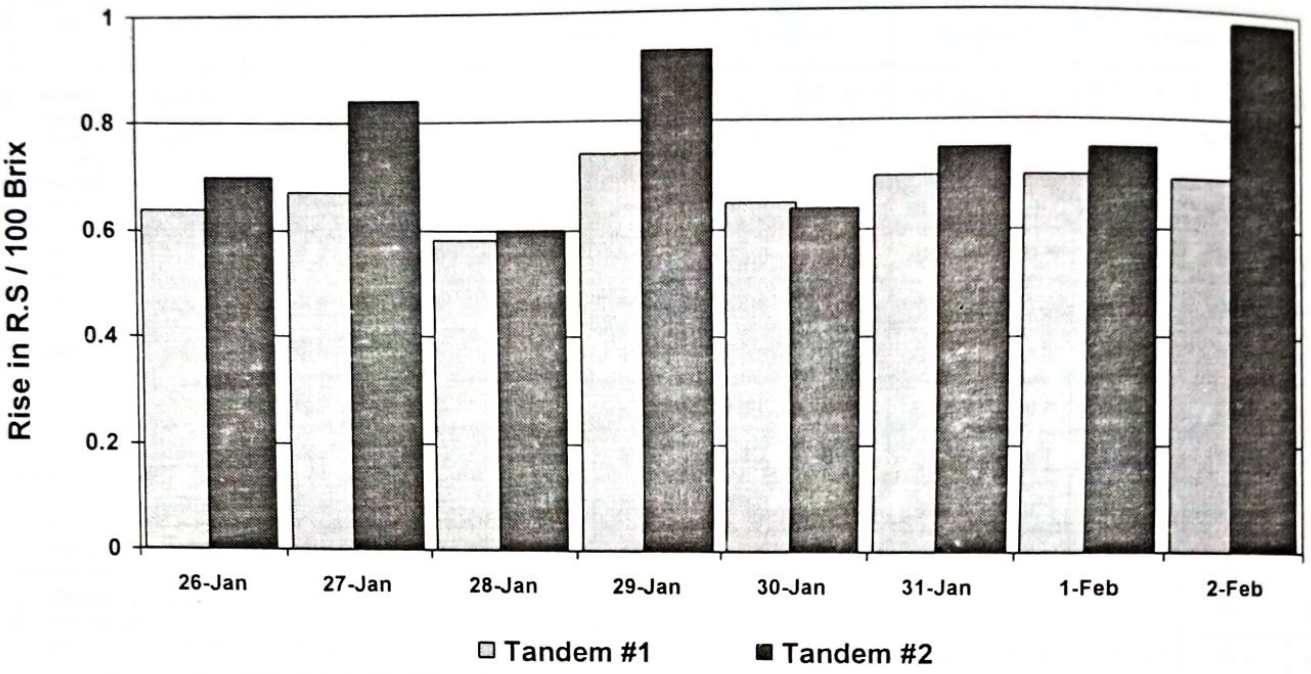
USE OF BIOCIDE (X) AT TANDEM # 2

TABLE # 2

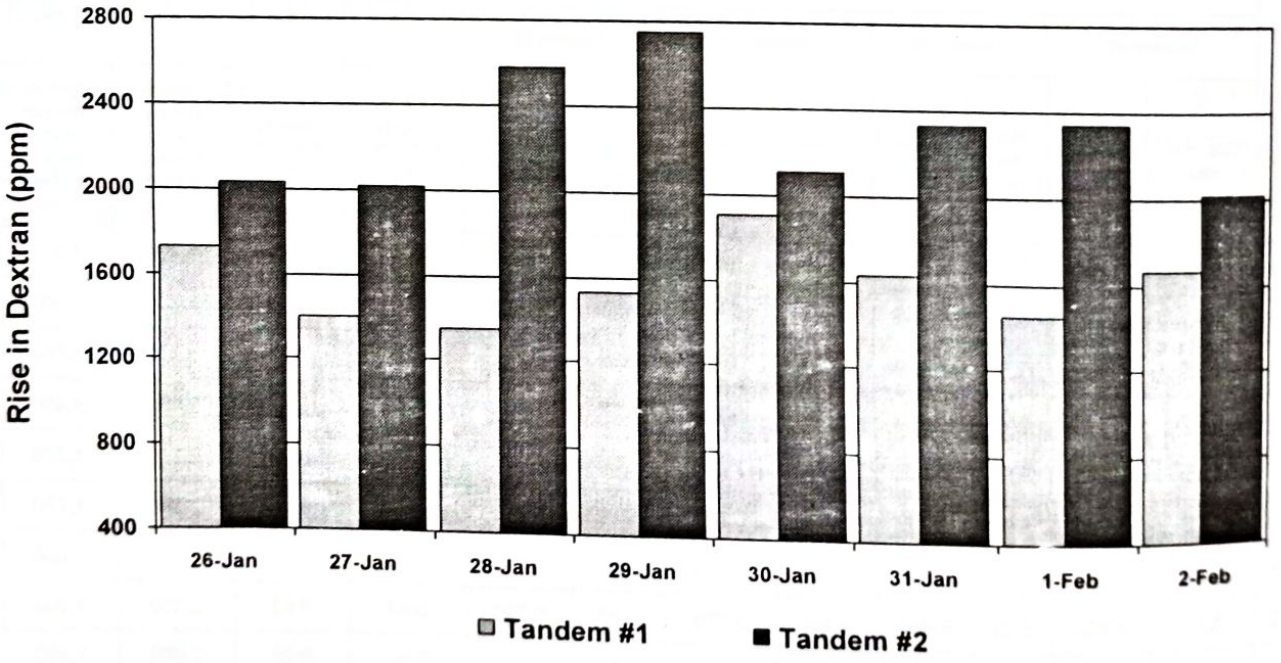
Date	Primary juice				Mixed juice				Tandem #1	Tandem #2	Tandem #1	Tandem #2
	Tandem #1		Tandem #2		Tandem #1		Tandem #2					
	R.S / 100 Brix	Dextran (ppm)	R.S / 100 Brix	Dextran (ppm)	R.S / 100 Brix	Dextran (ppm)	R.S / 100 Brix	Dextran (ppm)	Rise in R.S / 100 Brix	Rise in R.S / 100 Brix	Rise in Dextran from Primary to Mixed Juice	Rise in Dextran from Primary to Mixed Juice
10 FEB	5.70	8,200	5.88	8,400	6.56	9,690	6.45	9,610	0.86	0.57	1,490	1,210
11 FEB	6.18	7,370	5.92	7,200	6.93	9,870	6.58	8,800	0.75	0.66	2,500	1,600
12 FEB	5.38	7,700	6.30	7,650	6.20	9,510	6.95	9,410	0.82	0.65	1,810	1,760
13 FEB	6.10	7,620	6.20	7,710	6.88	9,710	6.90	9,160	0.78	0.70	2,090	1,450
14 FEB	5.43	6,980	5.90	7,020	6.23	9,350	6.66	8,390	0.80	0.76	2,370	1,370
15 FEB	6.20	7,020	5.89	7,500	6.96	9,410	6.68	9,250	0.76	0.79	2,390	1,750
16 FEB	5.85	7,890	5.31	8,060	6.67	9,850	5.99	9,580	0.82	0.68	1,960	1,520
17 FEB	5.77	7,620	5.39	8,460	6.60	9,770	6.02	9,720	0.83	0.63	2,150	1,260
Average	5.83	7,550	5.85	7,750	6.63	9,645	6.53	9,240	0.80	0.68	2,095	1,490

COMPARISON OF TANDEM RESULTS USE OF BIOCIDE (X) AT TANDEM # 1

Rise in R.S / 100 Brix

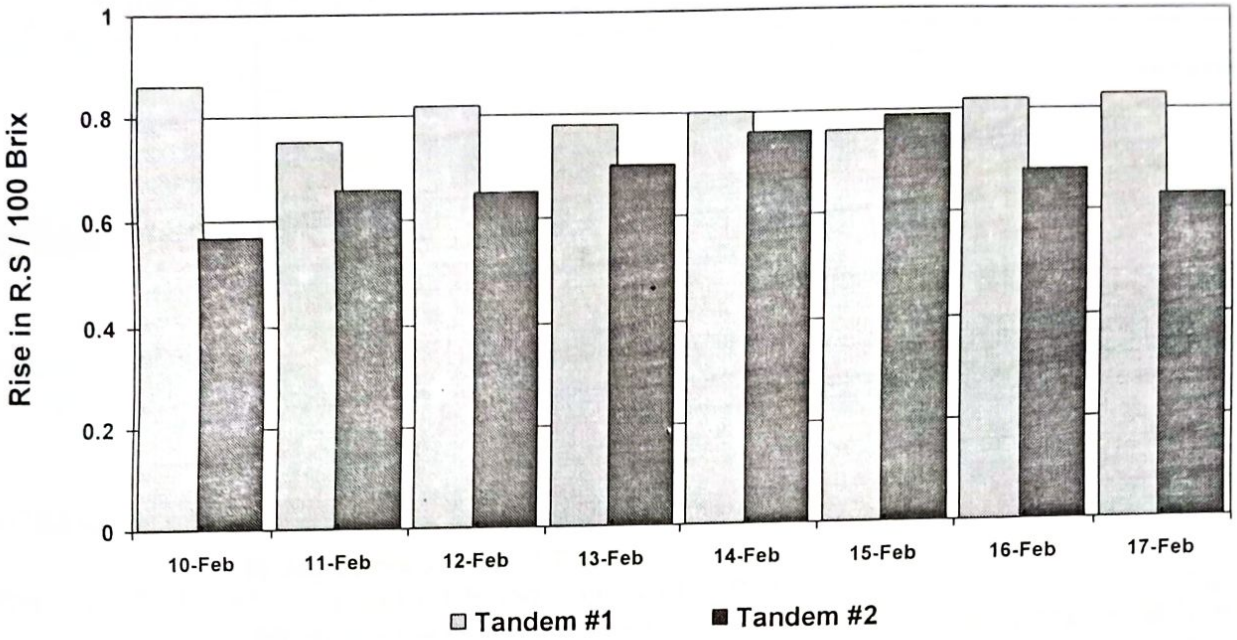


Rise in Dextran from Primary Juice to Mixed Juice

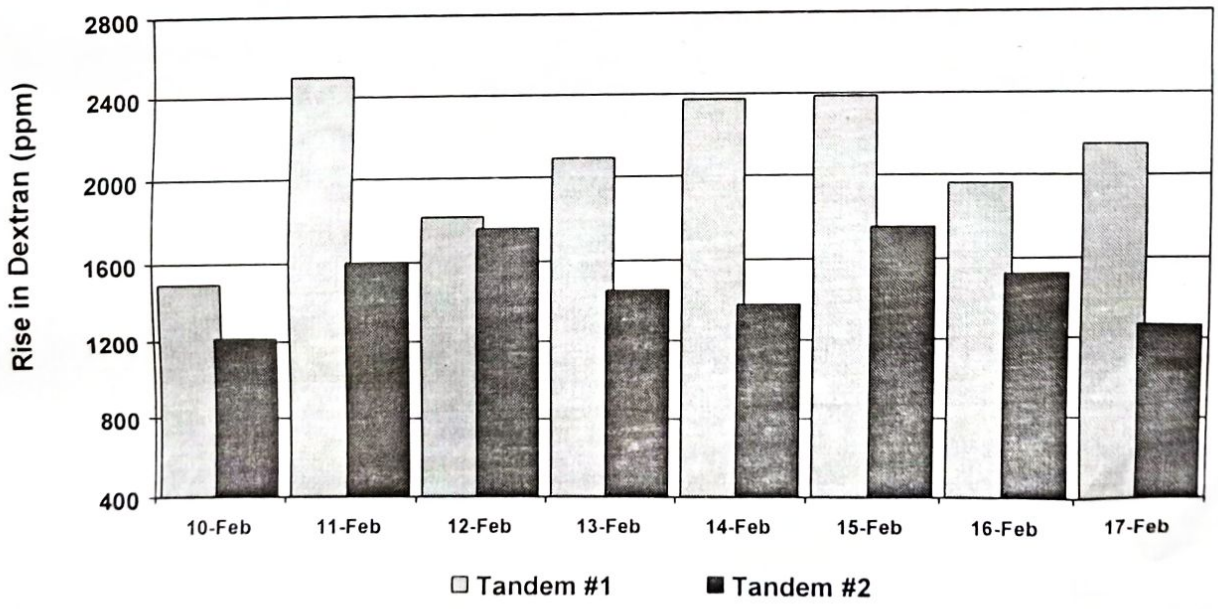


COMPARISON OF TANDEM RESULTS USE OF BIOCIDE (X) AT TANDEM # 2

Rise in R.S / 100 Brix



Rise in Dextran from Primary Juice to Mixed Juice



ESTIMATED LOSS OF SUCROSE

Use of Biocide (x) at Tandem #1

Estimated sugar loss between primary and mixed juice can be determined by using Brix and Reducing Sugar

Description	Tandem #1		Tandem #2	
	Primary Juice	Mixed Juice	Primary Juice	Mixed Juice
Brix %	18.26	14.53	18.02	14.52
R.S %	1.06	0.94	1.04	0.95
R.S % Brix	5.80	6.47	5.77	6.54

Calculations:

Increase of R.S % brix from primary to mixed juice for tandem #1 = (6.47-5.80) = 0.67 gm (100 gm solids)

The mean brix of primary juice is 18.26 = 100 gm of juice
100 brix of primary juice = 100 x 100 / 18.26 = 547.65 gm of juice

Hence, 547.65 gms of juice in the mill system give R.S % brix increases of 0.67 gms 1,000 gms of juice will give R.S % Brix increases of 1.22 gms.
Since R.S results from the hydrolysis of sucrose in accordance with the following equation

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6 + 6.5\ Kcal$$

[342] [18] [180] [180]

Then, for 95 % of the measured increase in R.S grams of sucrose lost / 1,000 gms of juice = 1.22 x 0.95 = 1.16 gms

Sucrose loss / 1,000 kg of juice = 1.16 kg

Out of 1.16 kg sugar lost per ton of M.J, 62 % is due to microbial growth = 1.16 x 0.62 = 0.72 kg

Similarly, sugar lost per MT of M.J for tandem # 2 is 0.82 kg

Difference in loss = 0.82 – 0.72 = 0.10 kg for one MT of MJ

Use of Biocide (X) at Tandem #2

Description	Tandem #1		Tandem #2	
	Primary Juice	Mixed Juice	Primary Juice	Mixed Juice
Brix %	18.17	14.62	18.30	14.70
R.S %	1.06	0.97	1.07	0.96
R.S % Brix	5.83	6.63	5.85	6.53

For same calculation as above, difference in loss for one MT of MJ is 0.13 kg

CONCLUSION

- The average gain in sugar for one MT of MJ is 0.10 kg when biocide (x) is used at Tandem #1 against Tandem # 2 where Bleaching powder & formalin are used.
- Similarly, the average is 0.13 kg of sugar recovered at Tandem #2 by use of biocide (x) against Tandem #1 where Bleaching powder & formalin are used.
- The study shows that relatively better results were obtained by using biocide (x) against conventional chemicals.

RECOMMENDATION

In addition to physical sanitation, the use of proper chemicals plays a vital role in minimizing the sugar loss and enhancement of the system productivity. By effective mill sanitation, we can save a considerable amount by way of recovery.

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