



Energy Management in Sugar Industry – A Comparative study of Technical Performance of Sugar Mills of Gujarat & Maharashtra States.

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Abstract: No sugar factory can extract cent percent sugar content from sugarcane. A small amount of sugar content goes as normal process loss. If any sugar unit maintains its normal losses within the allowable normal losses, such sugar mills are considered as highly efficient mills. The rate of normal loss indicates the degree of efficiency of men and machines in sugar mills. It is noticed that there is a loss of sugar at all stages right from harvesting to final product, which is a serious economic problem of sugar industry. The sugar losses in the sugarcane have been classified into: (I) Known Losses or Determined Losses consist of (a) Bagasse loss; (b) Filter cake loss; and (c) Molasses loss; and (II) Unknown Losses or Undetermined Losses, which cannot be determined directly but as ascertained from the difference between sugarcane and sugar accounted for. Here, exercise is made by researcher to identify and explore the opportunities and potential of cost savings by improvements in Technical Performance Parameters of Sugar Mills of Gujarat State with comparison to that of Maharashtra State.

Key Words: Capacity utilization, Pol % Cane, Fiber % Cane, Sugar recovery % Cane, Cane crushing capacity.

I. INTRODUCTION

¹No sugar factory can extract cent percent sugar content from sugarcane. A small amount of sugar content goes as normal process loss. After making numerous researches in the sugar extraction methods and processes, the researchers fixed up an allowable maximum normal loss. If any sugar unit maintains its normal losses within the allowable normal losses, such sugar mills are considered as highly efficient mills. The rate of normal loss indicates the degree of efficiency of men and machines in sugar mills. It is noticed that there is a loss of sugar at all stages right from harvesting to final product, which is a serious economic problem of sugar industry. It is also observed that the overall loss of sugar contents from the point of pre-harvest to till the point of bagging is estimated between 5 percent to 35 percent. The quantum of loss depends upon the degree of geographical and technical factors affecting the sugarcane cultivation, transportation and production processes.

The sugar losses² in the sugarcane has been classified into:

- i. **Known Losses or Determined Losses** consist of (a) Bagasse loss; (b) Filter cake loss; and (c) Molasses loss. These losses are determined by multiplying their weight measured using weighting scales.
- ii. **Unknown Losses or Undetermined Losses**, which cannot be determined directly but as ascertained from the difference between sugarcane and sugar accounted for. These losses arise during chemical process or in mechanical process such as juice heating, syrup tanks, crystallizers, centrifugal and at bagging point.

II. OBJECTIVE OF THE STUDY.

The objective of the Researcher for this study:

- o To make comparative analysis of Technical Performance of Sugar Mills of Gujarat & Maharashtra States and identify the scope of improvements in various parameters in this respect. Technical parameters have impact on Energy cost of Plant. Energy cost as an input is a significant part of the total production cost of any concern enterprise/unit. If you do several things to keep yourself in line with your energy goals, you may find yourself able to really save money here.
- o To identify and explore the opportunities and potential of cost savings by improvements in Technical Performance Parameters of Sugar Mills of Gujarat State.

III. LITERATURE REVIEW:

The Data collected/ available from the public documents available from websites of Sugar Federations/Associations of Gujarat & Maharashtra State. Documents published by Sugar Institutes like Vasant dada Sugar Institute, Pune; various researches on Sugar Mills, etc.

IV. METHODOLOGY:

- 1) The Main Objective of the Study was to make comparative analysis of performance parameters of Sugar factories of Gujarat with Maharashtra State and identify the loss reductions measures to be adopted in this respect.
- 2) Comparative study of data of Sugar Mills of Gujarat & Maharashtra State.

V. DATA AND SOURCES OF DATA:

- 1) Primary Study of Data available from the public documents available from websites of Sugar Federations/Associations of Gujarat & Maharashtra State.
- 2) Secondary Study by exploring and referring Documents published by Sugar Institutes like Vasant dada Sugar Institute, Pune; various researches on Sugar Mills, etc.

VI. THEORETICAL FRAMEWORK:

¹No sugar factory can extract cent percent sugar content from sugarcane. A small amount of sugar content goes as normal process loss. After making numerous researches in the sugar extraction methods and processes, the researchers fixed up an allowable maximum normal loss. If any sugar unit maintains its normal losses within the allowable normal losses, such sugar mills are considered as highly efficient mills. The rate of normal loss indicates the degree of efficiency of men and machines in sugar mills. It is noticed that there is a loss of sugar at all stages right from harvesting to final product, which is a serious economic problem of sugar industry. It is also observed that the overall loss of sugar contents from the point of pre-harvest to till the point of bagging is estimated between 5 percent to 35 percent. The quantum of loss depends upon the degree of geographical and technical factors affecting the sugarcane cultivation, transportation and production processes.

The sugar losses² in the sugarcane has been classified into:

(I) Known Losses or Determined Losses consist of (a) Bagasse loss; (b) Filter cake loss; and (c) Molasses loss. These losses are determined by multiplying their weight measured using weighting scales.

(II) Unknown Losses or Undetermined Losses, which cannot be determined directly but as ascertained from the difference between sugarcane and sugar accounted for. These losses arise during chemical process or in mechanical process such as juice heating, syrup tanks, crystallizers, centrifugals and at bagging point.

Various Technical Performance Parameters of sugar mills vis-à-vis comparison of Parameters of Gujarat & Maharashtra State is as under:

1. Duration of season:

¹The duration of crushing season is used as one of the parameters of performance. Every sugar mill keeps records of gross seasonal days and net seasonal days. Gross seasonal days consist of net seasonal days and days spent for cleaning and repairing purpose during the crushing season. If any unit maintains the difference between gross seasonal days and net seasonal days at minimum level, such unit is treated as highly efficient unit. The net seasonal days are calculated with the following formula.

Net Seasonal Days = Total Hours Crushed

22 Hours

Each day consists of 22 effective working hours and 2 hours are kept for cleaning and maintenance. If any unit makes use of those two hours also, its net seasonal days may cross the gross seasonal days.

⁴As per basic principles and parameters/norms for evaluating the performance of factories for Efficiency Awards for the year 2013-2014 declared by Maharashtra State,

Capacity utilization = $\frac{\text{Total quantity of cane crushed during crushing season} \times 100}{\text{Normative crushing capacity} \times \text{Available days}}$

Available days = $\frac{\text{Total hrs. Crushing} + \text{Total hrs. lost}}{24}$

24

¹The length of the crushing season days depends upon the number of sugarcane suppliers come to the mill and the quantum of sugarcane bring with them; area under sugarcane cultivation; yield per hectare; number of cutting order issued by the Agriculture Department of the factory; monsoon and climatic condition; mood of the gate cane suppliers; crushing capacity of the factory and efficiency of engineering department of the sugar factory. If all of these factors are in favourable direction for a mill, such mill could achieve a high degree of efficiency in crushing seasons.

³The duration of season largely depends on availability of Sugar cane. For economic working of any mill, the duration of the crushing season should be around 160 days.

In Maharashtra, during crushing season of 2014-15, sugar mills were operated for an average 156 days with more than 23 Mills.

In Gujarat, during crushing season of 2014-15, sugar mills were operated for an average 164 days with more than 10 Mills above average.

2. Crushing Capacity Utilization:

¹The capacity utilization is one more parameter available to decide the degree of production efficiency of every manufacturing unit. Some of the manufacturing units can make use of its cent percent capacity but most of the time they cannot exceed it. But industries like sugar, cement, etc., work beyond their actual capacity as and when need arises. They work even during the stoppage time for cleaning, if cleaning is not needed.

Sometime sugar mills receive a large amount of sugarcane within a short span of time. Since sugarcane is a perishable raw material, it must be crushed as early as possible preferably within six hours after detaching from its root to get maximum rate of recovery. Otherwise, convertible sugar contents get converted into non-convertible sugar contents. Hence the sugar mills must take care of all these factors during crushing time.

Sugar mills can take benefits of over utilization of production capacity during the crushing period. The over utilization of capacity does not create any additional burden of fixed charges either in the form salary (permanent as well as seasonal) or in the form of other set-up expenditures. Any increase in number of breaks increases process cost. After all the sugar mills have to be remain closed for two third of its lifetime because of the material used for production is seasonal in nature. It is observed that the workers

also show their interest to work hard, some times without break during crushing season. The engineering departments of the mills generally keep their plant and machinery ready well before the season to run without any major breakdowns.

³The crushing capacity utilization is the most important factor in reducing the production cost. Optimum crushing capacity utilization results in reducing the use of oil, lubricants and process chemicals like lime, Sulphur, phosphoric acid, etc. Further with uniform and continuous operation, the higher capacity utilization can be achieved which ultimately results in reducing sugar losses, consumption of bagasse and steam.

In Maharashtra, during crushing season of 2014-15, the State average crushing capacity utilization was 100.86% which was same as that of previous season. Overall number of sugar mills have also shown improvement in capacity utilization as shown in Table below.

Table 1: Distribution of no. of sugar mills as per capacity utilization %

Capacity Utilization%	No. of mills	
	2014-15	2013-14
100.00% & above	77	75
80% & above, less than 100%	57	42
Less than 80%	42	40
Total	176	157

Source: Technical Performance of Sugar Mills in Maharashtra – Season 2014-15 and 2013-14/Vasant dada Sugar Institute-Pune/Page no. M-8

The sugar mills that took lead in this regard were Rena SSK (229.78%), Ambalika Pvt. (200.43%), New Phaltan Pvt. (178.56%), Siddhanth Pvt (165.57%) and Bhima Shankar Pvt (162.41%).

In Gujarat, during crushing season of 2014-15, the State average crushing capacity utilization was 88.92%. Overall number of sugar mills have also shown improvement in capacity utilization as shown in Table below.

Table 2: Distribution of no. of sugar mills as per capacity utilization %

Capacity Utilization%	No. of mills	
	2014-15	2013-14
100.00% & above	5	N.A
80% & above, less than 100%	7	N.A
Less than 80%	5	N.A
Total	17	N.A

The sugar mills that took lead in this regard were Narmada (182.45%), Pandvai (143.84%), Gandevi (123.57%), Vadodara (113.31%) and Mahuwa (109.90%).

3. Lost hours % to available hours:

¹The production efficiency of sugar manufacturing units cannot be judged only on the length of crushing season and the level of capacity utilization. The efficiency of the various processing and pre-processing departments can be judged on the basis of differences between total number of hours available for crushing and the actual hours crushed during a particular season. No sugar mill has a record of total hour available equal to the total hours crushed. At least 10 percent of the total hours are lost due to various reasons, which is treated as normal loss of hours. If any unit shows its performance lesser than the allowable normal loss hours, such units are put under the category of 'efficient time managing units'. The manufacturing section-in-charge is responsible to keep the records of lost hours. Generally the lost hours are attributable to five major causes viz., cane shortage, mechanical, process, cleaning and miscellaneous such as rain, holiday, etc.

³The continuous crushing of cane throughout crushing season is one of the important factors for any sugar mill to achieve optimum technical performance. In sugar mill, stoppages mainly occur due to the following reasons.

1. Cane shortage
2. Mechanical and electrical defects
3. General cleaning
4. Miscellaneous such as untimely rain, strikes, etc.

With proper planning, timely action and adopting preventive maintenance, mill stoppages can be kept at minimum. The preventive maintenance of machinery and equipment during off-season can reduce the mechanical and electrical stoppages. An efficient cane harvesting and its transportation with minimum time for crushing can minimize down time due to cane shortage.

In Maharashtra, the average lost hours % to available hours during the season 2014-15 was reduced by 1.48 units (10.16%) as compared to 11.64% in 2013-14. During the period under report, 08 sugar mills (55.68%) maintained their down time within the prescribed maximum limit of 10% (as laid by Govt. of India). As required cane was available in time, there was reduction in average lost hours % to available hours in Central and north-east zones.

In Gujarat, during year 2014-15, 10 out of 17 Sugar Mills (58.82%) maintained their down time within the prescribed maximum limit of 10% (as laid by Govt. of India).

4. Cane quality:

³The quality of cane is of paramount importance in getting higher sugar recovery. It also affects the productivity and efficiency of a sugar mill. The quality of cane is dependent on values of (1) Pol % cane, (2) Fibre % cane, (3) Brix % cane and (4) Purity of primary juice.

4.1 Pol % cane:

⁵Juice Sucrose or Pol Per Cent: The juice sucrose per cent is the actual cane sugar present in the juice. It is determined by using a polarimeter, hence sucrose per cent is also referred to as pol per cent. For all practical purposes pol % and sucrose % are synonyms. Now a days an instrument called sucrolyser is also available for determining sucrose % in juice.

⁶Pol % Cane Should not be less than 11.5.

³In Maharashtra, during crushing season of 2014-15, the average Pol% cane of the State reported as 13.26 was slightly decreased as over the previous season of 13.34.

During season 2014-15, 29 sugar mills have achieved Pol % cane of 14.00% and above. The sugar mills viz. Olam Agro Pvt.(15.40%), Mahadik Sugar Pvt. (15.13%), H. K. Ahir SSK (15.10%), Dalmiya Sugar Pvt. & Gurudatt Pvt. (each 15.06%) and DT.R. Kumbhar SSK (15.01%) achieved Pol% cane of 15.00 and above.

In Gujarat, during year 2014-15, sugar mills have achieved average Pol% cane of 12.059%. No any Sugar Mill achieved Pol% cane of 14.00%. However, Sugar Mills viz. Bardoli (13.208%) & Gandevi (13.387%) have achieved Pol % cane above 13%.

4.2 Fibre % cane:

Energy Conservation in Co-generation in Sugar Mills

Fibre % cane varies between 12 and 16 % depending upon the variety of the cane, cultural practice, age of the cane, etc. Generally Fiber-rich variety has low Sugar % which is more detrimental for the profitability of the factory. So developing Fiber rich variety for the sake of enhancing the power output is not profitable. Immature can has less Fiber % and Sugar %. So immature can reduces both power and sugar revenue and affects the profitability of the factory. Over-matured can has more Fiber % but less Sugar %. So the overall profitability is not in favour of Over-mature cane. Having maximum Sugar % and optimum Fiber %, Matured Cane maximizes the profitability of the factory. Under identical conditions, Specific Power Generation with 12% Fiber Cane is 94.5 and that of 16% Cane is 138.5% kW.

⁶Fiber % Cane Should not be more than 17.

³In Maharashtra, during crushing season of 2014-15, the average fibre% cane was 13.41% as same as previous In Maharashtra, during crushing season of 2014-15, season 13.44%.

In Gujarat, during crushing season of year 2014-15, the average fibre% cane was 13.725%.

4.3 Brix of primary juice:

⁵Juice Brix: Juice Brix refers to the total solids content present in the juice expressed in percentage. Brix includes sugars as well as non-sugars. Brix can be measured in the field itself in the standing cane crop using a Hand Refractometer. This is usually referred as a Hand Refractometer Brix or HR Brix. In the field using a pierce collect composite juice samples from several canes. Then place a drop of the composite juice sample in the Hand Refractometer and measure the Brix reading.

The circular field gets darkened relative to the Brix level, which could be easily read. The HR Brix meter has graduations from 0 to 32 per cent. The HR Brix readings can be separately taken from both top and bottom. A narrow range indicates ripeness of the cane, while a wide difference indicates that the cane is yet too ripe. On the other-hand if the bottom portion of the cane has lower Brix value than the top, it means that the cane is over-ripened and reversion of sugar is taking place.

³The maturity of cane is judged from the brix of primary juice. For good performance, the brix % primary juice should be around 20%. In Maharashtra, during crushing season of 2014-15, the average brix% primary juice is increased to 19.29% from 19.18% of previous season 2013-14.

4.4 Purity of Primary juice:

⁵Purity Coefficient: It refers to the percentage of sucrose present in the total solids content in the juice. A higher purity indicates the presence of higher sucrose content out of the total solids present in juice. The purity percentage along with sucrose percent aids in determining maturity time.

$$\text{Purity Percentage} = \left(\frac{\text{Sucrose \%}}{\text{HR Brix}} \right) 100$$

A cane crop is considered fit for harvesting if it has attained a minimum of 16% sucrose and 85% purity.

³Purity of primary juice gives an indication of proportion of sugar present in the juice along with other dissolved solids. Higher value of purity is always desirable.

In Maharashtra, during crushing season of 2014-15, the average purity of juice was 84.84% against 84.75% of previous season 2013-14.

In Gujarat, during crushing season of 2014-15, the average purity of juice was 82.451% (Gandevi Sugar) against 83.705% (Gandevi Sugar) of previous season 2013-14.

5. Sugar recovery % Cane:

¹Rate of recovery is another important parameter indicates the degree of production performance. The rate of recovery is nothing but the percentage of sugar content extracted from sugarcane. The sugar content in cane differs from region to region and from time to time. The sugar content in sugarcane does not have any correlation with the yield per hectare. High degree of sugar contents fetches a high rate of white crystal sugar return. The input of sugarcane and output of sugar production is measured in term of percentage.

The degree of sugar contents in sugarcane depends upon the quality of soil, sugarcane variety and seed, impact of monsoon, pesticides and fertilizers used and cropping pattern. The rate of recovery depends upon percentage of sugar content in cane and also depends upon the efficiency of men and machines in the factory.

⁹Recovery of Sugar from the cane provides basis for determining the price per Quintal of Sugar cane. Recovery rate is most important factor in determining the profitability of Sugar Mills.

¹⁰Sugar recovery in sugarcane varies from state-to-state average sugar recovery in the country is 10.25% (P).

³Sugar recovery is the most vital economic indicator of any sugar mill. The Sugar recovery mainly depends on the quality of cane which also includes types of cane varieties, their maturity at the time of harvest and total sugar losses during processing. The following table provides data on number of mills achieving sugar recovery % cane at different levels.

Sugar recovery % cane	No. of mills	
	2014-15	2013-14
12.50% & above	23	21
12.00% & above, less than 12.50%	8	10
11.50% & above, less than 12.00%	18	21
11.00% & above, less than 11.50%	41	22
Less than 11.00%	90	83
Total	180	157

Source: Technical Performance of Sugar Mills in Maharashtra – Season 2014-15 and 2013-14/ Vasant dada Sugar Institute-Pune/Page no. M-10

Table 4: Distribution of no. of sugar mills as per Sugar recovery % cane.(Gujarat)

Sugar recovery % cane	No. of mills	
	2014-15	2013-14
12.50% & above	0	N.A.
12.00% & above, less than 12.50%	0	N.A.
11.50% & above, less than 12.00%	1	N.A.
11.00% & above, less than 11.50%	1	N.A.
Less than 11.00%	15	N.A.
Total	17	N.A.

³In Maharashtra, during crushing season of 2014-15, the State achieved average sugar recovery of 11.31% with slight decrease of 0.08 units as compared to previous season 2013-14 (11.43%).

Three private sugar mills from Kolhapur District of Maharashtra viz. Olam Agro Pvt. recorded the highest sugar recovery 13.40% of the season 2014-15 followed by Dalmiya Sugar Pvt. & Gurudatt Pvt. each with a sugar recovery of 13.34%. In all 90 (50%) sugar mills achieved the average 11.00% and above out of which 23 sugar mills in the State reported sugar recovery of 12.50%.

In Gujarat, during the period 2014-15, no any Sugar Mill achieved average sugar recovery of 10.370% with slight decrease of 0.753 units as compared to previous season 2013-14 (11.123%).

Gandevi Sugar Mill (11.721%) & Bardoli Sugar Mill (11.240%) have recorded above 11% sugar recovery. All other Sugar Mills have reported less than 11% sugar recovery.

6. Milling performance:

³Extraction of maximum sugar from cane into the mixed juice with minimum loss in bagasse is the ultimate aim of milling section. The characteristics like added water % Fibre, Pol % bagasse and reduced mill Extraction (RME) indicates the performance of milling section of sugar mill.

6.1 Added water % Fibre

Use of hot imbibition water at 80 °C in a large quantity is very useful to improve the mill extraction of a mill. The use of added water % Fibre at 200 on Fibre is optimum for good mill extraction. However, many mills in Maharashtra State are not using imbibition water % Fibre at the desired level of 200. During the season 2014-15, average level of imbibition water used in the State was 190.57% as compared to that of 193.07% in the previous season. Only 45 sugar mills utilized imbibition water more than 200%. The highest utilization of imbibition water was reported by Bhaurao Chavan Unit-II (313.69%). Purti Sugar Pvt. (295.27%), Olam Agro Pvt. (285.79%), Dt.R. Kumbhar SSK (267.60%) and Wainganga Pvt. (259.96%).

In Gujarat, highest Added Water % Fibre reported at level of 250.79% in Gandevi Sugar Mill against 255.758% in Maroli Sugar Mill.

6.2 Pol % bagasse

¹The Bhargava Sugar Industry Enquiry Commission (BSIEC) has given maximum loss allowed between 0.9 and 1.1 percent.

³In Maharashtra, the average Pol % bagasse was 2.38% during season 2014-15 and 53 sugar mills reported their Pol % bagasse above 2.50. It indicates that there is still scope to reduce loss of sugar in bagasse by adopting good milling practices.

In Gujarat, the average Pol % bagasse was 1.732% (highest in Gandevi Sugar Mill) during season 2014-15.

6.3 Reduced mill Extraction (RME)

³Mill Extraction and Reduced Mill Extraction (RME) indicate mill performance. The performance of mill depends upon the Fibre content in cane. Higher Fibre content increases difficulties in getting a good mill extraction. Therefore, RME is more useful in comparing the performance of milling tandem of two and more sugar mills or of same sugar mill at different intervals of time period. RME indicates the mill extraction of sugar mill that would be obtained if Fibre content was 12.50% on cane.

In Maharashtra, during the season 2014-15, the average RME of the State was 95.13%, which was same as that of previous season. Total 21 sugar mills achieved RME of 96% and above.

In Gujarat, against ⁸benchmark of 96%(Maximum), during the season 2014-15, the highest RME of 96.68% achieved by Gandevi Sugar Mill against 96.66% of 2013-14.

7. Boiler house efficiency:

⁷Any sugar industry mill heart component is Boiler and to maximize beneficiary output from sugar mill, there is need to maintain efficiency of Boiler with the design efficiency. So, boiler efficiency test is necessary for find out variation of boiler efficiency related to its MCR values. Hence it is necessary to find out the current level of efficiency for performance evaluation, which is mandatory for energy conservation action in industry.

Boiler efficiency is a relationship between energy supplied to the boiler and energy output received from the boiler. It is expressed in percentage.

$$\text{Boiler Efficiency} = \frac{\text{Energy exported by the fluid (Steam, water)} \times 100}{\text{Heat provided by the Fuel}}$$

³The boiling house performance of any sugar mill can generally be judged from boiling house recovery and reduced boiling house recovery (RBHR). The boiling house recovery of sugar mill indicates % extraction of sugar that was available in mixed juice. Performance of boiling house is dependent on purity of mixed juice. Hence, RBHR is more useful (which is calculated for mixed juice purity equivalent to 85%) for comparing the performance of the boiling house of different sugar mills having different mixed juice purity.

In Maharashtra, during the season 2014-15, boiling house recovery remained 89.12 compared to 89.41 of previous season.

7.1 Reduced boiling house recovery (RBHR)

³In Maharashtra there is marginal decrease of 0.29 units in average RBHR as compared to previous season (90.60%). Out of 176 sugar mills, 125 sugar mills were achieved the standard norm of RBHR (minimum of 90.00%). The number was 118 in the previous season. During the season 2014-15, there were 8 sugar mills which achieved RBHR of 92% and above. The front runners in this respect were Madhukar SSK (93.08%), Sharad SSK (92.53%), Sonhira SSK (92.32%), Panngheshwar Pvt. (92.21%), Bhaurao Chavan (Unit-IV) SSK (92.20%), Bhaurao Chavan SSK (92.06%) and Bhaurao Chavan (Unit-II) SSK (92.05%).

In Gujarat, against ⁸Benchmark of 91% (Maximum), highest RBHR achieved is 92.98 (Mahuwa Sugar Mill) in 2014-15 against 92.21 (Narmada Sugar Mill) in 2013-14.

7.2 Final molasses purity and molasses % cane

³The sugar loss in final molasses is the highest loss amongst all the losses. The extent of this loss depends on purity and the quantity of final molasses produced. The purity of molasses depends largely on the efficiency of clarification of juice, working of pan, crystallizer and centrifugal stations. The purity of final molasses also depends on the exhaustibility of the molasses, which ultimately depends on juice quality, the percentage of reducing sugar and ash content present in it. The final molasses purity should be as low as possible. Usually the final molasses purity below 30% is considered as satisfactory.

¹The Bhargava Sugar Industry Enquiry Commission (BSIEC) has given maximum loss allowed 0.1 percent.

³In Maharashtra, during season 2014-15, overall molasses purity was 32.35 compared to previous season 2013-14 of 31.85. During season 2014-15, molasses % cane was 4.15 compared to previous season 2013-14 of 4.02.

In Gujarat, during season of 2013-14, the highest Molasses Purity was 28.9227% (Narmada Sugar Mill) and 2014-15 it was 29.19% (Narmada Sugar Mill). In Gujarat, during the season of 2014-15, Molasses% cane was 4.691%.

8. Total Sugar losses:

³Total sugar loss achieved by any sugar mill in a crushing season is one of the important norms for assessing the technical performance of different mills.

¹The Govt. of India in its order (dated 31/05/1988) has specified the maximum limit for total sugar loss as: (a) 2.2 percent for the plant set up as per 1973 standard; and (b) 2.0 percent for the plant set up as per 1987 standard specifications.

³The total sugar losses need to be kept below 2% by an efficient sugar mill. Sugar mill is dependent on fibre% cane, milling, boiling house performance, efficiency of plant machinery and skilled manpower.

During 2014-15 crushing season, Maharashtra State sugar industry's average sugar loss% cane was 1.976 against 1.931 in 2013-14. Out of 176 sugar mills that sent their final manufacturing reports, 92 sugar mills achieved the total sugar losses below 2.000%; 55 sugar mills achieved it in the range of 2.000% to 2.200% and remaining 29 sugar mills recorded it 2.200% and above.

9. Consumption of chemicals:

³The consumption of two major chemicals viz. lime and Sulphur used in sugar mills. It was observed that average consumption of lime was 0.165% and 0.154% on cane in season 2014-15 and 2013-14 respectively. Whereas average Sulphur consumption was 0.049% and 0.044% on cane respectively.

Under the category of store consumption, most of sugar mills had reported oil and grease as combined lubricant consumption. Therefore, the figures are combined as total lubricant consumed per tonnes of cane. The lime is used in sugar mill for juice clarification. For proper understanding of working of mills regarding lime consumption details about its use in processing and for other reasons need to be given separately.

VII. ANALYSIS:

Technical performance of both Maharashtra & Gujarat State is summarized as under.

Table 5: Technical performance of Maharashtra & Gujarat State

Sr. No.	Technical parameter	Expected norms	Actual performance 2014-15 (Maharashtra)	Actual performance 2014-15 (Gujarat)
1	No. of Crushing Days (Min.)	160	156	164
2	Sugar mills in operation	-	181	17
3	Cane crushing capacity (TCD)	-	6,64,000	67750
4	Cane crushed (lakh tonnes)	-	930.95	108.445
5	Utilization of crushing capacity % (Min.)	100.00	100.86	88.92
6	RME – Mittal % (Min.)	95.00	95.13 (Average)	96.68 (highest)
7	RBHR – Gundurao % (Min.)	90.00	90.31 (Average)	92.28 (highest)
8	ROE Mital-Gundurao % (Min)	85.50	85.91	N.A.
9	PoI % Cane (Min.)	11.5	13.25	12.059
10	Fibre % Cane (Max.)	17	13.41	13.725
11	Purity of Primary juice		84.84	82.451
12	Added water % Fibre	200	190.57 (Average)	250.79 (highest)
13	PoI % Bagasse	0.9-1.1	2.38 (Average)	1.732 (highest)

14	Final molasses purity	30%<	32.35 (Average)	28.9227 (highest)
15	molasses % cane (Max)	0.1	4.15	4.691
16	Sugar Production (Lakh tonnes)	-	105.05	12.40 (11245997 Quintal /Bag)
17	Sugar Recovery % Cane	-	11.31	10.370
18	Sugar losses % Cane (Max.)	2.20	1.976	
19	Lost Hours % to available hours (Max.)	10.00	10.16	12.94

VIII. RESULTS & DISCUSSIONS:

- 1) In Maharashtra, with Cane crushing capacity of 6,64,000 TCD, 930.95 lakh tonnes cane crushed i.e. per 1 TCD, 140.20 tonnes canes crushed. This is done with 100.86% Utilization of crushing capacity. Whereas, in Gujarat, with Cane crushing capacity of 67,750 TCD, 108.445 lakh tonnes canes crushed i.e. per 1 TCD, 160.07 tonnes canes crushed. This is done with 88.92% Utilization of crushing capacity
- 2) In Maharashtra, for an average 156 no. of Crushing Days, 930.95 lakh tonnes canes crushed i.e. 5,96,763 tonnes canes crushed per Day by 181 nos. of Sugar Mills. This means average 3297 tonnes canes crushed per Sugar Mill per Day. In Gujarat, for an average 164 no. of Crushing Days, 108.445 lakh tonnes canes crushed i.e. 66,125 tonnes canes crushed per Day by 17 nos. of Sugar Mills. This means average 3889 tonnes canes crushed per Sugar Mill per Day.
- 3) In Maharashtra, with Cane crushing capacity of 6,64,000 TCD, 105.05 lakh tonnes Sugar produced i.e. per 1 TCD, 15.82 lakh tonnes Sugar produced. Whereas in Gujarat, with Cane crushing capacity of 67,750 TCD, 12.40 lakh tonnes Sugar produced i.e. per 1 TCD, 18.30 lakh tonnes Sugar produced.
- 4) In Maharashtra, Sugar Recovery % Cane remained 11.31% whereas in Gujarat, it remained 10.37% in 2014-15, which is just nearer to state-to-state average sugar recovery in the country of 10.25%. Therefore, Sugar Mills of Maharashtra are more profitable than Gujarat due to more price per Quintal of Sugar cane.
- 5) Lost Hours% to available hours, against norms of 10%, In Maharashtra, it remained 10.16% whereas in Gujarat it remained 12.94%. Therefore, the performance of both cannot be put under the category of 'efficient time managing units'. Attention is required on management of proper mechanical process, cleaning, etc. as other attributable major causes viz., cane shortage, rain, holiday, etc. is beyond control.
- 6) Against expected norms of 11.5 minimum, **Pol % cane i.e.** Juice sucrose % which is actual cane sugar present in the juice remained 13.25% in Maharashtra & 12.059 in Gujarat. Against expected norms of 17% maximum, **Fibre % cane i.e.** Fiber-rich i.e. over-matured cane has low Sugar % is 13.41 in Maharashtra & 13.725 in Gujarat which is slightly lower affecting profitability of the factory. Higher value of **purity of primary juice** which gives an indication of proportion of sugar present in the juice along with other dissolved solids is always desirable, is found more i.e. 84.84% in Maharashtra as compared to 82.451 in Gujarat. All these three parameters attributed to quality of cane which is of paramount importance in getting higher sugar recovery & also affects the productivity and efficiency of a sugar mill, are found more in favour of Maharashtra compared to Gujarat.
- 7) **Milling performance i.e.** extraction of maximum sugar from cane into the mixed juice with minimum loss in bagasse is the ultimate aim of milling section, which depends on (1) Added water % Fibre, (2) Pol % bagasse & (3) Reduced mill Extraction (RME). Against optimum use of **hot imbibition water** at 80°C, many mills in Maharashtra State are not using at level of 200 (average 197.57% in 2014-15). In Gujarat, highest Added Water % Fibre reported at level of 250.79% in Gandevi Sugar Mill. Against maximum loss allowed between 0.9 and 1.1 %, in Maharashtra, the average **Pol % bagasse** was 2.38% during season 2014-15. In Gujarat, the average Pol % bagasse was 1.732% (highest) in 2014-15. It indicates that there is still scope to reduce loss of sugar in bagasse by adopting good milling practices. Against desired level of 95.00 minimum of **RME**, in Maharashtra it remained average 95.13 & in Gujarat 96.68 highest.

IX. CONCLUSION.

- 1) Tonnes canes crushed with Utilization of crushing capacity by Gujarat which is more compared to Maharashtra State
- 2) In Gujarat, average tonnes canes crushed per Sugar Mill per Day which is more compared to Maharashtra State.
- 3) In Gujarat, per 1 TCD, tonnes of Sugar produced is more compared to Maharashtra State.
- 4) In Maharashtra, Sugar Recovery % Cane remained more compared to Gujarat in 2014-15.
- 5) As far as Lost Hours% to available hours is concerned, the performance of both Maharashtra & Gujarat cannot be put under the category of 'efficient time managing units'. Attention is required on management of proper mechanical process, cleaning, etc. as other attributable major causes viz., cane shortage, rain, holiday, etc. is beyond control.
- 6) All three parameters i.e. (1) **Pol % cane**, (2) **Fibre % cane** & (3) **purity of primary juice** are found more in favour of Maharashtra compared to Gujarat led to sugar recovery, productivity & efficiency in Maharashtra.
- 7) From study, it indicates that there is still scope for Maharashtra to reduce loss of sugar in bagasse by adopting good milling practices.

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