

Research Article

Quantification of Sugar Content Loss in various Byproducts of the Sugar Industry

Chetan Sharma* and Vikas Kumar†

†Mechanical Department, National Institute of Technology, Kurukshetra (Haryana), India

Accepted 25 May 2015, Available online 01 June 2015, Vol.3, No.2 (June 2015)

Abstract

In this paper we tried to concentrate on the factors associated with the operational losses of sugar during the sugar manufacturing process. Data is collected from The Kaithal Cooperative Sugar Mills Ltd. (2500 TCD) which is situated in Kaithal District of Haryana State. The major reasons of losses in sugar are due to sugar in bagasse, final molasses, filter cake and unknown factors. The sugar losses occurred in any sugar plant in a season of crushing is one of the important term of accessing the technical performance of the sugar plant. Main objective of this study is to find out various losses in operations in detail. We found after analyzing the data that the loss of sugar in bagasse, molasses, and press-mud cake and in unknown losses is 2.07% of the total cane crushed and out of the total sugar loss at The Kaithal Cooperative Sugar Mill Ltd. sugar loss in bagasse is 25.34 % while sugar loss in filter cake is 2.89 %, sugar loss in molasses is 66.94 % and sugar undetermined loss is 4.83 % respectively.

Keywords: Sugar industry, Sugar cane juice. Sugar losses, Sugar manufacturing.

1. Introduction

India is known as the true home of sugar and sugarcane. Indian mythology supports the above written facts as it contains legends showing the origin of sugarcane. India is the second largest producer of sugarcane.

During the manufacturing of sugar from sugarcane some amount of sugar is lost. If the total losses of sugar are minimized it will ultimately affect the cost reduction, hence production cost of sugar will be decreased this will directly leads to cost effectiveness.

Sugar Manufacturing Process

The sugar manufacturing process consists of juice extraction, juice clarification, evaporation, crystallization, centrifuging, drying and packing. Steam generation using bagasse as fuel for electricity generation.

1.1 Background of the problem

The area of the problem was been studied under The Kaithal Cooperative Sugar Mills Ltd. (2500 TCD) which is situated in Kaithal District of Haryana State for the total loss of sugar in the sugar production process. The sugar that has been lost in the process from the extraction of sugarcane to the crystallization of sugar was been examined.

The Research method used by the researcher is descriptive type and the data collected by various sources by interviewing the chief chemist of The Kaithal Cooperative Sugar Mills Ltd. The secondary data collected by various sources such as reference books, annual manufacturing reports of sugar factories, sugar related websites.

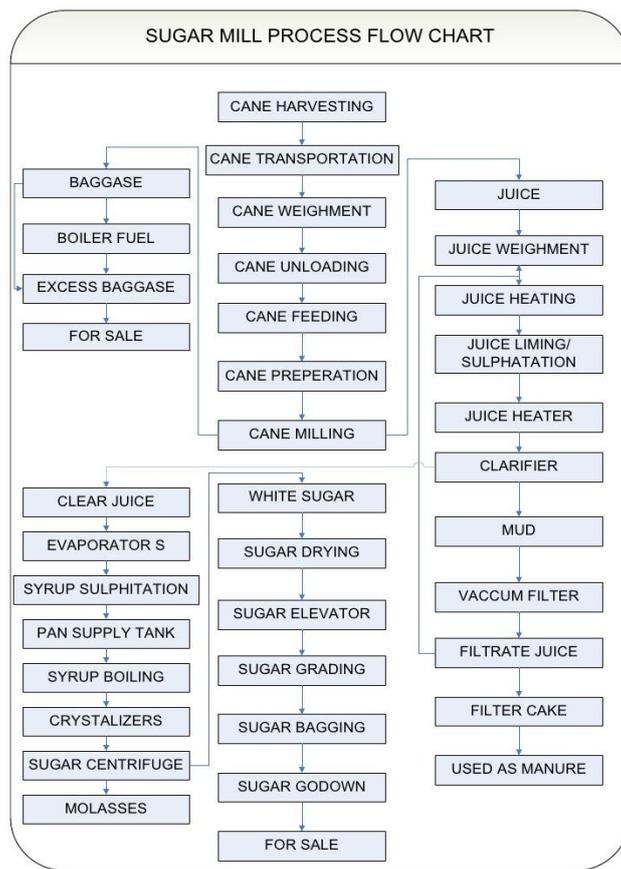
1.1.1 Problem of Losses of Sugar in Sugar Industries

Total sugar losses achieved by any sugar factory in a crushing season are one of the important terms for accessing the technical performance of the sugar plant. The total losses need to be kept below 2.10 % for sugar factories installed before 1994 and 2.20% after 1994. Sugar loss is dependent on Bagasse % cane, Milling, Boiling house performance, Efficiency of plant machinery and Skilled manpower. Mainly sugar is lost in the following areas:

1.1.2 Sources of losses in sugar during manufacturing

- i) Sugar in filter cake- The juice extracted as mixed juice contain bagasse cello particles mud and other impurities which may range into 0.03 % to 0.080 %
- ii) Sugar in Bagasse – Extraction of maximum sugar from cane into mixed juice with minimum loss in Bagasse is the ultimate aim of milling section
- iii) Sugar in Molasses – The sugar in the final molasses is 1 % to 1.30 %. The loss in final molasses depend on the cane quality and process achieved.

*Corresponding author: Chetan Sharma



iv) Sugar Undetermined – the un - determined losses of sugar are due to mechanical or chemical this may vary according to different factories the loss are 0.01 % to 0.11 %

1.2. Data presentation of the problem

1.2.1 Item wise Operational Loss of Sugar During Sugar Manufacturing Process:

1. Sugar in Bagasse
2. Sugar in Filter Cake
3. Sugar in Molasses
4. Unknown losses

2. Literature Review

Wasna Jaturonrusmee and Chantana Nuntiwattanawong (2008)

Invert sugar has several disadvantage properties that play an important role in many food applications. It has a high affinity for water and is the cause of making products retain moisture. Invert sugar also affects the caramelization process, producing a browning effect. In this study, the possibility of minimization of sucrose inversion during the industrial production of sugar cane was investigated by the variation of the important parameters, i.e. temperature and pH of sugar cane juice for each of samples. The amounts of sucrose and reducing sugar alerting during the sucrose inversion process were determined by the values of % Pol and %

reducing sugar (% RS), respectively. Starting with the study of temperature and pH effects of the sucrose solution with the concentration of 16 Brix, used as a sample model, it was found that no change in amounts of reducing sugar and sucrose was observed at room temperature (34°C) in the pH range of 5-11.

At pH 3, the amounts of reducing sugar increased and the amount of sucrose decreased as the time increased. These indicated that the process of sucrose inversion should better occur in more acidic solutions. Compared to the room temperature, it was found that the increment of temperature led to enhance the process of sucrose inversion. This was depicted by higher values of %RS and lower value of % Pol as the temperatures were elevated. The experiments were also done with real sugar cane juice, i.e. first, last, and mixed juice. The tendency of changes of the amounts of reducing sugar and sucrose in sugar cane samples by varying temperature and pH were found to resemble to those for the sample model.

The increment of temperatures have also affected on a reduction of amounts of sucrose in each sugar cane juice. In addition, it could be concluded that the acidity of the solution affects sucrose easier to be broken down to glucose and fructose molecules.

Love DJ and Muzzell DJ (2009)

Maximising sucrose recovery can also be viewed as minimising sucrose losses. From this perspective, since sucrose loss in final molasses is normally the largest component of the total sucrose loss, minimising

sucrose loss in final molasses is vital to maximising sucrose recovery. A set of 'Three Laws of Molasses Loss' is proposed as a basis for guiding actions necessary to minimise the loss of sucrose in final molasses. The rationale behind each of the laws is described, along with how they relate to good operational practices. The three laws are also used as an aid to interpreting standard factory performance figures.

Priyanka Saxena, R.P. Srivastava & M.L. Sharma (2010)

In the present era of economic liberalization, sugar has become an important commodity for human consumption as well as trade.

The global importance of this versatile sweetener could be judged by the fact that its consumption is expected to go much high upto 2020 AD as compared to the present level. Sugarcane plant, once detached from ground loses its machinery to synthesize sucrose. Thus a well ripened harvested crop may lose its sugar within a few days, which tends to increase further due to high ambient temperature. These losses tend to increase during processing, especially in those units where hygienic conditions are rather unsatisfactory. The post harvest sugar loss is one of the most vexing problems of sugar industry and has attracted widespread attention in the recent years. A study was carried out to examine the effect of staling h on three early and three mid-late maturing varieties in view of biochemical changes occurred in staled cane juice from 0 h - 96 h. The ambient temperature ranged around 40-42°C. TSS, sucrose, purity coefficient, dextran, proteins, free amino acid contents, acid and neutral invertases were assayed. The sucrose content rapidly deteriorated after 24 h staling. The invert sugar and dextran content increased rapidly after 48 h. free amino acid contents increased rapidly up to 72 h. Free amino acid contents were higher in early group of varieties than mid-late group of varieties. Findings indicated that both the group of varieties fastly deteriorated sucrose content after 24 h. Higher dextran formation was observed after 48 h in most of the early varieties due to higher concentration of sucrose thereby TSS increased during staling periods. It may be inferred that the early maturing varieties should be crushed within 24 h and mid-late maturing varieties within 48 h after harvest under high ambient temperature. Mid-late maturing varieties showed lower values of dextran, free amino acid content, protein and invertase activities. Therefore, these varieties were found capable in retaining quality characters up to longer durations after harvest. It has also been observed that mid-late varieties having lower sucrose content than early varieties, deteriorated less during staling. In the cane juice of early maturing varieties, where sucrose and brix values were higher than mid-late, produced relatively higher invertase activities, dextran, free amino acid content and proteins in the late staling h possibly due to higher microbial infestation.

Pisal D.T (2011)

(i) On the basis of an empirical survey of sugar losses during sugar manufacturing in six major co-operative sugar mills in Pune district it was observed that the average sugar loss in bagasse in all six mill is around 32%. The production of sugar can increase by minimizing the losses of sugar during manufacturing process. Use of the better cane variety to improve the pol % of sugar and the management of the best practices handled in the process of the sugar factory leads to improve the production of sugar and minimization of losses. Proper application of these leads to increase in sugar production so also profit to sugar factory and nation both.

(ii) At present, the situation of the Indian sugar production can improve with all these measures. In the financial year of 2004-2005, India had to import 8.89 Lakh tons of sugar from different countries due to the huge decline in the national sugar production. These measures would have a long term effect on the sugar production of the state and therefore of the entire country.

(iii) It concludes that the sugar production in India increase and sugar factories become more profitable by adopting innovative techniques to avoid sugar losses in manufacturing.

3. Analysis of material wastage in kaithal cooperative sugar mill

The analysis on material wastage has been carried out keeping the following points in mind:

1. The material balance on the basis of total cane crushed per annum, yielding different byproducts like bagasse, filter cake, final molasses and their constituents have been quantified.
2. The process loss of sugar content has been worked out on annual basis from laboratory test report (as taken in appendix A).

Annual Data for the year 2013-14 (refer: Appendix A)

Total cane crushed=33,42,524.30 Qntls
Bagasse = 968997.80 Qntls (28.99% on cane)

Bagasse = Fibre +(Sugar and Non sugar) + water
 = 46.94% + 2.64% + 50.42%
 =454847.56 Qntls +25581.54 Qntls+ 488568.7 Qntls
 25581.54 Qntls = sugar + non sugar
 = 1.81% + 0.83% (on bagasse)
 = 17538.86 Qntls + 8042.68 Qntls

Filter Cake (F.C.) = 116988.35 Qntls (3.50% on cane)

Filter Cake = Bagacillo + Sugar + Wate
 = 23.29% +1.71% +75% (on F.C.)
 107681.777 Qntls = 27246.58 Qntls + 2000.50 Qntls
 + 87741.26 Qntls

Final Molasses = 177488.04 Qntls (5.31% on cane)

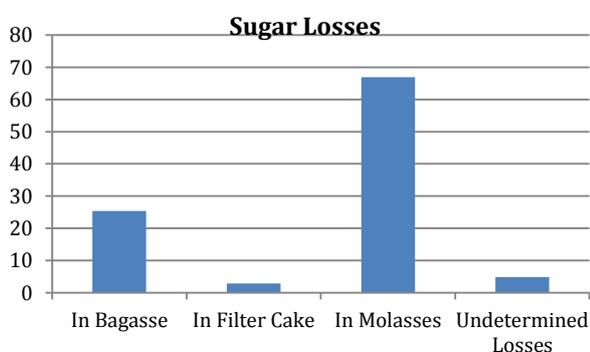
Final Molasses = Sugar + non sugar + water
 = 26.10% + 62.08% + 11.82% (of Molasses)
 139550.216 Qntls = 46324.38 Qntls + 110184.57 Qntls
 + 20979.08 Qntls

Table 1 Process Loss of Sugar content

Sr. No.	Sugar Losses in.....	Quantity tones/hr
1.	Bagasse	17538.86
2.	Filter cake	2000.50
3.	Final molasses	46324.38
4.	Unknown losses	3342.52
5.	Total losses	69206.26
(2.07% on cane)		

Conclusion

1. Loss of sugar in bagasse, molasses, and press-mud cake and in unknown losses is 2.07% of the total cane crushed.



The above graph shows that out of the total sugar loss at The Kaithal Cooperative Sugar Mill Ltd. sugar loss in bagasse is 25.34 % while sugar loss in filter cake is 2.89 %, sugar loss in molasses is 66.94 % and sugar undetermined loss is 4.83 % respectively.

2. The pol % in the cane depends on different factors including the climate for the sugar crop, it varies from the season to season.
3. The water percentage sprayed towards the cake is less; the juice is contained with impure material like mud particles and other cello particles.
4. The extraction of sugar from bagasse is the main aim for further process of cogeneration or steam generation.
5. There are many factors that are undetermined for the loss of sugar in the process i.e. mechanical and chemical.

References

Wasna Jaturonrusmee and Chantana Nuntiwattanawong (2008): Minimization of sucrose losses in sugar industry by ph and temperature optimization.

Love DJ and Muzzell DJ (2009): Minimising sucrose loss in final molasses: The three laws of molasses loss

Priyanka Saxena, R.P. Srivastava* & M.L. Sharma (2010): Impact of cut to crush delay and bio-chemical changes in sugarcane.

Pisal D.T (2011): Operational losses in sugar cooperatives factories during Sugar manufacturing process in pune distri

A Directory Indian Sugar Industry, Bhartiya Sugar (1983), Pune P.1

Final annual manufacturing report 2013-2014 or Farm RT8C (Appendix A) of The Kaithal Cooperative Sugar Mill

Agarwal R.N. 1976, Sugar Industry in India. My Recollections, Popular Prakashan Private Ltd., First Edition, Bombay , P.

Bhartiya Sugar Directory 1987-88, Pune P

E.hogot,(1986)Hanbook of Sugar Enginerring, Elsevier,Vol.1 P.247-249

National Federation of co-operative sugar factories Ltd., Co-operative sugar directory and Year Book 1983-84, New Delhi, 1985, P.

Annual Sugar report .Department of food and public distribution govt of India <http://fcamin.nic.in/Annual%20>.

Indian Sugar Industry at Glance http://www.vsisugar.com/india/statistics/world_indiasugar.htm# <http://www.vsisugar.org>.

World Sugar market [http:// www. indiansugar. com/ briefings/ wsm.htm](http://www.indiansugar.com/briefings/wsm.htm).