Proceedings STAI, Factory Processing
Vol. 82 (2024) : 331-334
doi: 10.69794/82SAC/978-81-969264-0-3/331-334

Effective Control of Starch and Dextran Levels in Sugar Process with Novel Bio-Additives

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Received : June 14, 2024; Accepted : June 28, 2024

ABSTRACT

Increase in starch and dextran levels during the process of sugar manufacturing creates many complex problems like increased viscosity levels and raise in microbial colonies. In addition, increase in non-sugar content drop in purity levels and enormous increase in contamination levels are the major hurdles faced by sugar industry resulting in the loss of efficiency. Effective control of starch and dextran not only enhances the efficiency of the process but minimizes the losses resulting in smooth functioning of the process. Special bio-additives are used for the effective control of starch and dextran at nominal dosage levels. This paper deals with the treatment methodology of bio-additives and the advantages achieved by effective implementation during the process of sugar.

Keywords : Starch, dextran, sugar processing, bio-additives.

INTRODUCTION

The sugar cane contains substantial residues of Polysaccharides, specifically dextran and starch, this which cause tremendous problems in sugar processing by causing inversion of sugar as well as interfering in processing.

Leuconostoc mesenteriodes is often found associated with deteriorated sugar cane. This microbe has the ability to convert alpha-glucan polysaccharides (dextran) from the sucrose released from cane following stalk damage and/or harvesting delays.

The sucrose released dextran interferes with insoluble particle aggregation and settling, filtration rates, evaporation and boiling rates and overall process control. During evaporation the dextran concentration increases which interferes with crystal formation and crystal separation. This increases sucrose loss to the final molasses. Besides the problems, dextran occludes in the crystal resulting in elongation of same specifically in raw sugar manufacture.

Starch is another important part of polysaccharide complex of sugar cane which is present in sugar cane juice creates difficulties in producing white / refined sugar. Starch is a natural polysaccharide of sugar cane juice. Starch contains two fractions, amylase and amylopectin, both of which are polymers of sugar. Starch concentration depends upon many factors such as cane variety and growth condition. Starch can delay crystallization in the vacuum pans preventing molasses exhaustion, increasing viscosity resulting in higher sugar loss. Presence of starch in sugar results in haziness of sugar solution.

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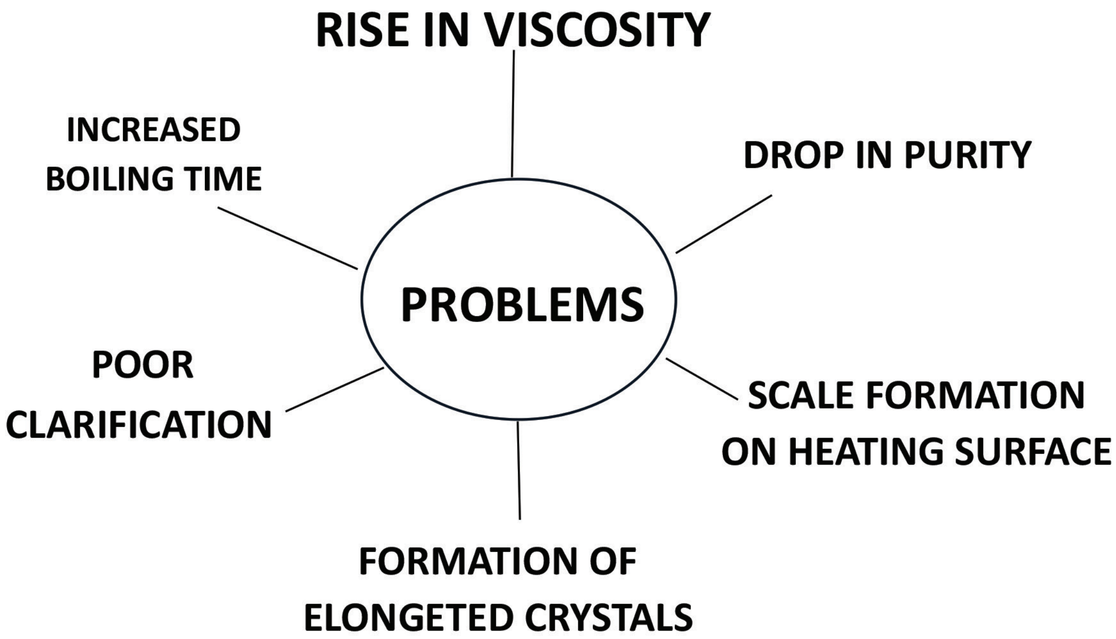

Figure 1 : Negative impact of starch present in sugar

Starch Source and effects

Starch contamination enters the juice system from sugar cane

Cane starch contain two fraction amylose and amylopectin

Cane starch content varies with cane variety and age

Approximately 30 % cane starch transfer into raw sugar crystal during process

Presence of starch increase intermediate liquid viscosities

Effects on filtration

Ineffective purification and decolourisation process

Interfere in crystallization and leads to crystal elongation

Creates high viscosity high steam % cane & poor clarification

250-350 ppm starch in raw sugar creates process difficulties in refineries.

Dextran : Source and effects

Dextran is a complex glucose polymer.

Leuconostoc infection increases formation of dextran and interfere in sugar processing.

Increase in dextran level influences on process intermediate like viscosity, reduction in plant recovery, elongated crystal formation and hinders evaporation rate.

Every unit of dextran consumes four molecules of sucrose.

Production of poor quality sugar due to dextran.

MATERIALS AND METHODS

Bio - enzyme for dextran

Bio - enzyme for dtarch

Dosage in ppm on Cane for plantation White sugar process

Product	Dosage (ppm) on Cane
SUCHME dextranase	1.0 - 2.0 ppm
SCUHEM starch enzyme	2.0 – 4.0 ppm

Both the products were added, diluted with cold water to 5 – 10% concentration and fed continuously with the help of a dosing pump.

Application of enzymes

Various studies at plant scale have revealed the high effectiveness of enzymes in combating the problems associated with dextran and starch. Since enzymes are highly specific in nature, a combination of two or more enzymes should be used for degradation of starch and dextran. Currently the two predominant enzymes viz., alfa amylase for starch reduction and dextranase for dextran reduction, are being used in sugar processing.

Based on the above methodology, we have done extensive R and D and successfully came out with the following two formulations which have excellent performance in controlling dextran and starch, in a most economical way and care is taken that these products are heat stable.

Suchem Bio enzyme dextranase

The product is a fungal dextranase (E.C. 3.2.1.11, 1, 6-alpha-D-glucan 6-glucanohydrolase) obtained by the controlled fermentation of *Chaetomium erraticum*. The enzyme is an endo-dextranase capable of randomly hydrolyzing the interior alpha-1, 6-glucosidic linkages of dextran and its degradation products. This activity rapidly reduces the viscosity of dextran solutions. The initial hydrolysis products of dextrazyme are soluble poly-saccharides and oligo-saccharides of varying lengths. Prolonged hydrolysis with the product results in the formation of glucose and lower levels of isomaltose and isomaltotriose.

The product has a high degree of specificity for the interior bonds of the dextran polymer versus the end sugar unit. The product also has a pH optimum appropriate for application to mixed juice / syrup / melt, high thermal stability and no invertase activity.

Dosing mechanism

The enzymatic breakdown of dextran molecules should ideally take place at an early stage of the sugar production process. For example, by adding the enzyme to the raw juice during or right after extraction. The benefits will then be seen in the juice clarification process and the early stage of evaporation.

In cane sugar mills where sugar extraction is carried out using a roller mill crushing process, the most convenient point for the product is a holding tank between the primary and secondary juice heaters.

In mills where a layout preventing adequate enzyme retention time prior to juice evaporation, the product may be added to the syrup, either directly or after the last effect evaporator. Although it shows good thermal stability in high brix syrups around 85^0C, an extended time or an increased enzyme dosage may become essential. That may be supported by analyzing the amount of high molecular weight dextran present at any given time by ICUMSA – CSR haze method.

Suchem Bio-enzyme for starch control

The product is an optimized formulation of hydrolyzing alpha amylase enzyme along with an excellent preservative best suited for the hydrolysis of starch, and other unwanted bacteria present in the sugar juice/ raw sugar melt .The enzyme present in the product has the dual stability at high temperature and low pH thus making the product more effective in the breaking of high density starch molecules. The enzyme present in the product is of endoamylase that has the capability of hydrolyzing 1,4-glucisidic bonds resulting in the reduction of viscosity of the gelatinized starch and finally resulting in the formation of soluble dextrin's and oligo-saccharides there by the viscosity of the substrate is kept under control all the time.

Dosing mechanism

The enzyme for starch hydrolysis is a heat stable enzyme. To achieve the longest retention time, the optimal addition point in a sugarcane mill is during evaporation at the first vacuum stage, which is also called as third evaporation system. In a sugar refinery, enzyme addition should take place during first melting. In both operations, the enzyme will remain active until the final crystallization process.

During practical operational processes, indications are observed that combined use of both the products, in a cane sugar plant, diminish the detrimental effects of dextran and further reduce the viscosity of massecuites so that sugar crystallization is facilitated, and C molasses purity decreases further to the optimal level. Also, it is to be noted that the dosage points will vary depending on the operational parameters from mill to mill.

Advantages of using the bio-additives

With the above coordinated use of dextranase enzyme and starch reducing enzyme the following efficiency improvements are achieved.

Reduction in Final molasses purity by 1.0 Unit

Dextran level reduction by 45-55% (Min)

Starch level reduction by 50-60% (Min)

In addition to the above by continuous utilization of the above products process stabilization takes place leading to indirect benefits as mentioned below

Massecuite and molasses viscosity reduction

Boiling time reduction

Reduction in final molasses % cane

Better mud settling and filterability in rotary vacuum filter

Case Study: 1

Crushing 9500 TCD	
Application	Starch and dextran enzyme
Suchem Bio Additive	4 ppm Starch control
Application	Mix juice tank, Syrup and B-heavy molasses tank
Suchem Bio Additive	2 ppm dextran control

Results

Increase in recovery by 0.4%

Reduction in viscosity in molasses and boiling house

Reduced dextran levels by 50 %

Destruction of starch by 80 % and improved crystallization

Case Study: 2

Crushing	7500 TCD
Application	Starch and dextran enzyme
Suchem Bio Additive	4 ppm Starch control
Application	Mix juice tank, Syrup and B-heavy molasses tank
Suchem Bio additive	2 ppm dextran control

RESULTS

- Increase in recovery by 0.5%
- Reduction in viscosity in molasses and boiling house
- Reduced dextran levels by 52 %
- Destruction of starch by 70 % and improved crystallization

CONCLUSION

The Suchem bio additives utilization in the sugar processing yielded good results in terms of controlling starch and dextran levels there by the desirable enhancement of process efficiency has been established with consistant results. The improved process parameters have resulted in smooth operations in terms of reduced viscosities and enhanced recoveries.

ACKNOWLEDGEMENTS

The authors are thankful to STAI for giving us the opportunity to publish the paper.

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