



An Approach Towards Sulphur Free Sugar

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ABSTRACT

Most of cane sugar industry utilize double sulphitation process for production of consumable (plantation white) sugar. The double sulphitation process is less costly as compared to refined sugar process. Whereas the quality of plantation white sugar is deteriorated during storage and rate of deterioration highly depends on process adaptation, sulphur dioxide content, temperature and moisture content during bagging and this also influenced by climatic condition, because the sugar is hygroscopic in nature. Lime and sulphur dioxide gas are used for juice clarification to isolate suspended and non sugar particles from juice to good quality sugar. Whereas sulphur dioxide not only degraded the sugar quality during storage but also allergen compound to susceptible people. It may induce allergic reaction such as respiratory illness, skin irritation, diarrhea, headache, nausea and abdominal disorder. Due to higher SO₂ content in plantation white sugar and susceptible to color value, hence the Indian sugar is not competed on global trading. To consider the above issues, industry should take efforts to produce qualitative product without application of SO₂ in process. As a result, the Indian sugar industry will be dominated in the global market as well as serve a secure and safety food product to society.

Keywords : Health conscious, ecofriendly process, sulphur, hygienic sugar

INTRODUCTION

Sugar is essential part of diet consumed in our daily life. To meet the requirement of society, sugar is produced from sugar cane and beet by extracting and purifying the sugar content by adopting different process mechanism. The process followed by sugar industry are defecation, single sulphitation, double sulphitation and reprocessing of crude raw sugar for producing consumable sugar in industrial scale. People are consuming this sweetness agent as jaggery, raw sugar, plantation white sugar, refined sugar and liquid sugar. The main clarification chemical agents are lime and sulphur dioxide gas used in sulphitation process. Due to toxic nature of SO₂ gas, it is not only affecting the biological system of people mainly respiration but also a great constituent of water and air pollution. Secondly it minimizes the life span of equipment's,

machineries and high maintenance cost due to high corrosion nature. Hence the sugar industry is shared additional budget to safe the equipment's and used the alkaline agents to maintain the pH value of condenser water and also complicated effluent treatment process to meet the norms of state pollution control board as well as CPCB. Ultimately, it accelerated to increase the production cost of sugar and also influence the balance sheet of factory.

Sugar industry and socio economic of rural India:

The establishment of the sugar industry in rural areas ensures the socio-economic development and also supporting the national GDP. Sugar industry generates jobs directly in sugarcane cultivation, processing and distribution, providing employment to a large number of people in rural areas. Sugarcane farming becomes

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a source of income for rural farmers, leading to economic stability and growth in these communities. The establishment of sugar mills often necessitates the development of infrastructure such as roads, transportation networks and irrigation systems, which benefits the entire rural region.

Process followed for sugar production

The present practice followed by sugar factories are defecation process, double sulphitation process and refined the crude raw sugar to produce consumable sugar.

- *Defecation process:* In this process juice treated with milk of lime for clarification. The sugar produced from clarified juice after concentration & crystallization. This sugar is known as raw sugar. This sugar is directly consumed by people of some countries due to its good aroma nature and its nutritional value. It is also safer food ingredient as compared to sulphitation sugar. Whereas the shelf-life and quality of raw sugar highly depends on packaging, storage condition and humidity of atmosphere. The color value of raw sugar is varied from 400IU to 1200IU as per buyer's requirement. The quality of raw sugar degraded due to highly susceptibility to micro-organisms.
- *Refined sugar:* The refined sugar production from raw sugar by adopting the process methods. The raw sugar melted and clarification followed by either phos-flotation or carbonation then passed through the multi-bed filter, then after ion exchanger to remove the non-sugars and coloring matter from sugar solution. The refined sugar crystals are developed at crystallization station and separated at centrifuge. It is highly consumed by pharmaceutical, beverage and infant food industries. Its color value is below 45 IU and the SO₂ content is below 02 PPM. Whereas, the production cost is higher than other sugar production cost. It is safer food ingredient to people and the self-life of refined sugar is higher than the other sugars. The common people are not afforded to consume the refined sugar due to higher price in market.
- *Single sulphitation sugar:* The cane juice is clarified by lime and SO₂ gas, then concentrated

by MEE and converted to solid crystal by vacuum pans. The color value of this sugar is in the range of 80 IU to 120 IU. This sugar is also known as sulphur less sugar because of in this production process syrup is not treated by SO₂ gas. Hence the presence of SO₂ is below 10 PPM. To consider the allergen nature to sensitive people less than the double sulphitation sugar.

- *Double sulphitation sugar:* The cane juice is clarified by lime and SO₂ gas, then concentrated by MEE and again the concentrated juice known as syrup treated with SO₂, to bleach-up the coloring matter, reducing the viscosity of syrup, whiteness and luster of sugar. The dissolved sugar in sulphited syrup is converted to solid crystal at vacuum pans and separated by centrifugal machine this sugar is also known as plantation white sugar. The color value of this sugar is varied from 60IU to 120 IU and SO₂ content is varied from 20PPM to 70 PPM. It is highly susceptibility to respiratory system of sensitive people suffering by asthma and bronchitis.
- *Low-cost sulphur free sugar:* The cane juice treated with milk of lime for removing the suspended, colloidal particles, non-sugars and coloring matters. The filtrate juice from rotary vacuum filter shall be clarified by sedimentation process and the clear filtrate sent to juice reaction vessel for second time clarification with cane juice. The reason of filtrate juice clarification is to avoid recirculation of non-sugars, coloring matter and suspended particle in it. The filtrate juice clarification by sedimentation process will not only improve the clear juice quality but also increase the operational capacity of clarifier. The clarified juice from subsider/clarifier is concentrated up to desired Brix by multi effect evaporator and the syrup is clarified by phospho flotation system to remove the coloring matter and turbidity in syrup. After syrup clarification the treated syrup shall be passed through the multi bed filter followed by pressure filter. The viscosity of treated syrup is lower side as compared to sulphited syrup. Then the syrup sends to crystallization station to separate the sugar in liquid form to solid crystal. The sugar crystal in massecuite isolated from massecuite

with the help of centrifugal machine. After drying and cooling the sugar is bagged for marketing. The product sugar is safer food ingredient and suitable for sensitivity and non-sensitivity asthma people. The color value of final product is in the range 45 to 70 IU and sediment will be below the BSS standard. The production process is gaining popularity among health-conscious consumers because of process simplicity.

Application of sulphur dioxide on sugar production:

Sulphur dioxide is acted as a preservative, inhibiting the development of discoloration also preventing negative affect on process due to Brownian reaction. During process and it is also acted as viscosity reducing agent and improves the massecuite boiling. it ensures the sugar remains visually attractive white appearance. Sulphur dioxide functions as a effective antimicrobial agent. It prevents the growth of unwanted micro-organisms during the sugar processing stages. It also aids in the extraction of sugar from its raw source. It makes the process more efficient and cost-effective.

Sulphur dioxide on human health:

The color less sulphur dioxide is harmful component to human health, the harmful effect of gas depends on concentration and density of gas as well as the individual sensitivity & tolerance capacity. People have no ill effect by intake of sulphited sugar, however, those are more sensitive or with allergies to sulphur dioxide, Due to adverse reaction of SO_2 gas leads to diseases like asthma, bronchitis, skin irritation, and digestive discomfort. Hence it is wiser decision to avoid sulphited sugar intake, those are allergies to SO_2 compound. About one in nine asthmatics gives a history of asthma worsened by drinking 'soft drinks' containing sulphur dioxide. sometimes the floor staff worked at process industries are exposed to Sulphur dioxide during their working period. The regulatory agencies establish safe limits for Sulphur dioxide residues in food products to minimize health risks.

Sulphur Dioxide and Environmental effects

The air pollution will be occurred due to emission of sulphur dioxide gas to atmosphere as it is a toxic gas. It can damage trees and plants, inhibit plant growth,

and damage sensitive ecosystems and waterways. When sulfur dioxide combines with water and air, it forms sulfuric acid, which is the main component of acid rain. Acid rain can:

- cause deforestation
- acidify waterways to the damage of aquatic life
- corrode building materials and paints.
- SO_2 also reduces the visibility
- Damages the global ecosystem

As per the WHO air quality guidelines (World Health Organization 2021), the recommended 24-hour average SO_2 concentration should not be more than $40 \mu\text{g}/\text{m}^3$ for protecting human health.

The map shows sulphur dioxide concentration levels in India. Indo-Gangetic plains, central and eastern India are the hotspots of SO_2 pollution as these regions house a cluster of thermal power plants, petroleum refineries, steel manufacturing units and cement industries, according to the study. Map by Jayanarayanan Kuttippurath.

Effects of sulphur dioxide on sugar industry property

The sugar industry followed double sulphitation process for manufacturing of plantation white sugar facing number of problems such as

- Decline the life span of equipment, pipe lines, pumps and vessels
- Formation of hard scales on heating surface of pressure vessels
- Chocking of pipe lines
- Heavy sediment on final product
- Deteriorate the water quality of spray pond/ cooling tower water
- Increase the consumption of process, cleaning water treatment chemicals
- Increase the off- season maintenance cost
- Influence the production efficiency due to corrosion of pipelines and leakage at sulphur burner area.

Benefits of sulphur free sugar:

- *Natural Sweetness:* Sulphur less sugar holds its natural sweetness without any chemical additives. People will enjoy the flavor, pure and unadulterated taste of sugar.
- *Healthier Choice:* For individuals with sensitivities or allergies to sulphur compounds, sulphurless sugar is a safer option, free from potential adverse reactions.
- *Purity of Flavor:* If you are planning for baking a cake or sweetening your tea, the sulphur less sugar will give a clean, untarnished sugar flavor, enhancing the taste of your food creations.
- *Environmental Friendliness:* The production of sulphur less sugar often involves more eco-friendly methods, making it a best option for those who retain the sustainability and responsible consumption.
- *Adaptability:* Sulphurless sugar is a adaptable ingredient that can be used in a wide range of recipes without affecting the taste or texture of your creations. Whether you're making cookies, candies, or sauces, it's a reliable choice that won't compromise your cookery activities.
- *Keeping quality:* The keeping quality of sugar produced by sulphur less sugar process is much higher than sugar produced by sulphitation process.
- *Negligible corrosion effect:* When the SO₂ is eliminated from process and the process is carried with neutral pH for sugar production, So that the corrosion levels are negligible and improving the life of equipment, piping and pumps and minimize the maintenance cost for such corrosion related rectifications
- *Lower the turbidity level:* Removal of fine foreign particulate colloidal matter carryover with clear juice will be isolated from syrup by flotation clarifier , DBF and pressure filter.
- *Chemical consumption:* The process and cleaning chemical and ETP chemical consumption reduce drastically. Monitory benefit to sugar industry.
- *Better quality control:* Better quality control in respect of the color variation in clear juice will not affecting quality of finished product.
- *Inversion loss can be minimized:* Due all materials maintained nearly neutral pH.

General specification for sulphur free sugar

Description	Unit	Sulphur free Sugar
Polarization	%	≥ 99.80
Color	IU max	< 60
Moisture	% max	0.03
Ash	% max	0.04
R.S.	% max	0.04
SO ₂	ppm	<5
Turbidity	Abs.	< 40
Beverage Floc	–	Negative
Sediment	ppm	<10

- Monitory gain: Extra premium from institute buyers due to qualitative product.
- Ethanol production: Higher the ethanol yield as compared to sulphitation process feed stock.
- *Cost effective production process of sulphur free sugar:*
- The brix % mixed juice should be maintained below 15deg Brix, so that imbibition water % cane should be decided accordingly.

- The mixed juice shall be screened at two stages by rotary screen before sending to process house
- The mixed juice shall be heated up to $73 \pm 1^\circ\text{C}$. To consider the steam conservation, the mixed juice shall be heated at three stages.
- The heated juice shall be treated with milk of lime (max 100 Brix) in the reaction vessel and maintained the pH of treated juice 7.2.
- The limed juice to be heated up to $103 \pm 1^\circ\text{C}$ at three stage and transfer to subsider (clarifier) for settling purpose.
- The filtrate from rotary vacuum filter shall be clarified separately and the muddy juice from filtrate clarifier send to muddy juice receiving tank of main clarifier and the clear filtrate mixed with defecated juice for further clarification. This process will be improved the clear juice quality for process. Otherwise, the clear filtrate can be transferred to distillery for ethanol production.
- The clear juice from clarifier shall be screened with the help of static filter. Provision of cover with inspection door should be provided to avoid heat loss during screening and proper arrangement for removal of suspended particles on the screen.
- The clear juice is concentrated up to 62° brix at multi effect evaporator and vacuum shall be maintained max 22-inch hg at last effect evaporator.
- The syrup should be treated at syrup clarification system to removing the turbidity, coloring matter from syrup. Then clear syrup passed through the multi bed filter and bag filter. Approximately 95% turbidity of syrup shall be removed by above treatment (syrup clarifier, DBF and bag filter)
- The clear syrup is transferred to crystallization station for A1 massecuite boiling.
- The A1 and B-double cured sugar is melted for A M/c boiling (single stage boiling).
- A Light molasses shall be used for A M/c whereas AH molasses to be used with syrup for A1 M/c boiling.
- A1H molasses is used for B M/C boiling
- B M/c shall be double cured B sugar shall be melted used for A M/c and BL molasses shall be used for footing of B M/c.
- The B H molasses should be discarded from process house.
- The sugar from centrifugal machine should be conditioned (temp. below 38°C and moisture 0.03 %) properly before bagging to sustain the quality.

Precautions shall be taken during process

- The time span between cut to crush shall be maintained 24 hours maximum, accordingly prepared the cane harvesting scheduled.
- Try to minimize the foreign materials with cane
- Housekeeping from cane carrier to bagging house should be practiced strictly.
- Centralized chemical biocide application at cane preparation and juice extraction station (mill house/ diffuser) should be followed to avoid development of any contamination by micro-organisms.
- Steaming at mill house minimum once in a shift
- Application of biocide at filtrate Juice tank.
- Do not allow stagnation of water, diluted juice from cane carrier bottom to centrifugal station.
- Periodically cleaning of buffer tanks for mixed juice, defecated juice, syrup and molasses.
- Covered the syrup, molasses receiving tanks at pan station.
- Make provision of 1st vapor periodically spaying at top of syrup and molasses tanks.
- Daily cleaning of batch centrifugal chutes and sugar hoppers.

CONCLUSION

By adopting this process method for sulphur free sugar by sugar mills, it will give a great contribution to society by providing a safety food to customers, minimum the lime consumption and zero consumption of sulphur in process will be a great contribution to

control air and water pollution. It is an eco-friendly sugar production process. The sugar mills will also get additional monetary benefits due to lower side chemical consumption and extra premium due to sell of sulphur free sugar.

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REFERENCES

- Andrews and Godshall. Comparing the Effects of Sulphur Dioxide on Model Sucrose and Cane Juice Systems. Sugar Processing Research Institute, New Orleans, LA.
- B J Freedman (1980). Sulphur dioxide in foods and beverages: its use as a preservative and its effect on asthma. PMID: 7426352.
- Chaudhary Rashi (2022). Everything you need to know about sulphur in sugar 21 Nov., 2022.
- Kulkarni, V.M (2010). Modified single sulfitation process for producing better quality plantation white sugar. *Proc. Int. Soc. Sugar Cane Technol.*, 27:M.1-9.
- LiberEat. Sulphite Allergy | One of the 14 Major Food Allergens.
- Wong Sosanna (2021). A closer look at sSulphur dioxide in foods. *Food Safety Focus* 175 Issue, February.
- Narendra Mohan (2022). Sugar quality requirements: changing market dynamics. Sharkara April – June, 53(02)ISBN:978-93-5445-372-4.
- Narendra Mohan (2024). Industry needs to adopt forward-looking approach to produce sugar as per changing consumer behavior and other factors. Monday, 1 April
- Medhe P G (2024). Forward-looking approach: A necessity of the Indian sugar industry. Chini Mandi 10 Apr.