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Production of Sulphur-less Sugar

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Abstract: ***The paper describes the details of equipment and the process used to produce Sulphur-less sugar and advantages of sulphur-less sugar.***

Keywords: Raw sugar, Sulphur-less sugar, Colour, Turbidity, Sulphur-dioxide, Beverage floc, Conductivity ash, Sediment, Polarization

I. METHODS

Following internationally accepted ICUMSA methods are used for analysis of all intermediate products and final product, sugar.

1) Colour - ICUMSA GS 9/1/2/3-8 (2011)
2) Turbidity - ICUMSA GS 2/3-18 (2013)
3) Sulphur Dioxide - ICUMSA GS 2–33 : 2022
4) Beverage floc - ICUMSA GS 2/3-40 : 2019
5) Conductivity ash of sugar - ICUMSA GS 2/3/9–17 (2011)
6) Sediment content of sugar - ICUMSA GS 2/3/9–19 (2007)
7) Polarization - IS 15279 : 2003 clause 5 & 6

II. INTRODUCTION

In India mostly plantation white sugar is produced by double sulphitation method i.e. juice sulphitation prior to clarification followed by syrup sulphitation. The sugar produced by double sulphitation contents higher quantity of sulphur in the range of 20 to 70 ppm or may be higher depending upon the operation of individual sugar factories. Due to higher sulphur content in sugar it is not accepted in International market. As per international norms, sulphur less than 20 ppm in sugar is acceptable.

In the case of sulphitation process, the equipment and piping in operation get corroded resulting in the requirement of repair, maintenance and replacement cost.

The plantation white sugar produced by the double sulphitation process is said, to have an adverse effect on the human body. Growing awareness of using sulphurless sugar for the benefit of the human body, environment, additional revenue etc. it is now right time for Indian sugar industry to switch to the production of sulphurless sugar.

Process steps for production of Sulphur-less sugar:

1) Production of raw sugar by juice defecation
2) Raw sugar melting – screening – clarification – filtration
3) Melt concentration
4) Pan boiling, crystallization and centrifugation

III. DESCRIPTION OF THE PROCESS AND EQUIPMENT USED

A. Producing good quality raw sugar

The initial stage is of producing Raw sugar. Following scheme will help to produce better quality raw sugar.

1) Two stage rotary juice screens at mill house
2) Raw juice flow stabilization
3) Hot raw juice screening system
4) Juice defecator with pH automation
5) Defecated juice flow stabilization
6) Auto temperature control of defecated juice
7) Short retention time clarifier
8) Continuous Pans etc.

Raw sugar specifications

Colour	: 400 to 600 IU
Turbidity	: Less than 250 IU
Sulphur-dioxide	: Less than 20 ppm
Conductivity ash	: 0.04 to 0.05 %
Sediment	: Below 100 mg/kg
Polarization	: 96 to 97 %

B. Producing Sulphur-less sugar

1) Raw Sugar Melting And Screening

Raw sugar shall be delivered to sugar minglers. Minglers are generally kept below raw sugar centrifugal machines. Alternatively, belt conveyor is kept below centrifugal and mingler is kept above sugar melter. Raw sugar magma will be produced using hot water. Magma brix shall be kept at around 92°.

Raw sugar magma shall be fed to sugar melter. 3 compartment type horizontal sugar melter is used for melting raw sugar. Brix of melt at the outlet of melter shall be 60 to 62° and temperature shall be in the range of 65 to 70°C to achieve better screening efficiency. To maintain above parameters auto Brix and temperature control is required.

Raw sugar melt is then passed through rotary melt screen. This melt screen is of fully closed type to minimize temperature drop during screening. Automatic timer operated washing arrangement is provided to wash the screen periodically as per system requirement.

2) Melt Clarification System

Screened melt is delivered to screened melt tank. Colour precipitant is added according to raw melt flow. Screened melt is then pumped to melt heater and temperature at outlet of the heater is around 80-85°C. Bled vapours from first or second body evaporator shall be used as heating media.

Heated melt is then passed through a three compartment type melt reaction vessel cum aerator. Lime sucrate and phosphoric acid is added in the first compartment of reaction vessel. First two compartments are provided with stirrers for proper mixing of chemicals. Auto pH control system is provided to achieve desired pH of treated melt which is generally around 7.

Treated melt overflows to aeration compartment fitted with aeration disc for micronized air mixing with the melt. Flotation polymer is added at the outlet of aerator.

Aerated melt is then fed to flotation clarifier where scum is removed from top surface. Clear melt withdrawal is from bottom takeoff coil and with telescopic valve arrangement it will be delivered to clear melt tank.

Scum resulted from melt clarification is collected in scum tank and then fed to mud tank or scum de-sweetening system for effective de-sugarization. Sweet water from first stage will be delivered to sugar melter and final scum to mud tank of rotary vacuum filter.

Clear melt is collected in clear melt tank and then pumped to Multibed filters.

Chemical usage: - Depends on the quality of raw sugar

Following chemicals are required for melt clarification system:

a)	Colour precipitant	: 100 to 250 ppm
b)	Phosphoric acid	: 250 to 350 ppm
c)	Lime sucrate or MOL	: to maintain desired pH of treated melt
d)	Flotation polymer	: 10 to 12 ppm

With respect to melt flow rate Colour precipitant, Phosphoric acid and Flotation polymer dosing shall be in auto mode. Dosing of Lime sucrate is adjusted to meet desired pH of treated melt.

3) Multibed Filtration System

There are minimum 2 nos. Multibed filters (1 no in operation and another in backwash mode). 6 layered filter media will help to filter any suspended solids which may escape through clear melt.

Filtered melt is then collected in filtered melt cum back wash tank. Backwash tank partition will be always in filled condition so as to allow back wash at any given time. Filtered melt is then pumped to bag filters fitted with 50 micron filter bags installed before two effect melt concentrators.

4) Melt Concentrators

Filtered melt brix is in the range of 58 to 60 degree. To reduce steam consumption the brix is raised to 68 to 70 degree and then pumped to pan supply tanks. Two effects of FFE, plate type evaporator or Robert body evaporators are generally used.

5) Pan Boiling Scheme

Generally R1, R2 and R3 pan boiling scheme is adopted. The concentrated fine liquor is pumped to pan supply tanks for feed to pans. The liquor is boiled in vacuum pans. For refined massecuite vacuum pan should be low head with fast natural circulation rapid boiling calandria. First boiling uses concentrated fine liquor as feed. Runoff separated from this massecuite is used as feed for second boiling, runoff from second boiling is feed for third boiling.

R3 massecuite runoff and surplus raw washing are processed in raw sugar pan boiling station.

6) Centrifugal Station Operation

a) At Batch type centrifugal machine, R1 massecuite is cured and R1 Sugar, R1 heavy and R1 light molasses are separated.
b) R1 sugar is dried through hopper and then grading is done through grader. Sugar is then transferred to silo and then sugar bagging is done.
c) R1 heavy and R1 light molasses is send to R2 massecuite through pumps for the further processing.
d) R2 massecuite is also cured in batch type machine.
e) R2 sugar is dried, graded and then bagged through silo.
f) R2 Molasses is pumped to R3 massecuite as a feed for it.
g) R3 massecuite is cured in batch machine.
h) R3 sugar is dried, graded and then bagged through silo with R2 sugar.
i) R3 molasses is pumped to raw sugar pan boiling station.

7) Automation

Entire system of melt clarification and filtration is fully automatic and controlled through DCS.

Following are the control schemes

a) Raw melt brix and temperature
b) Melt flow stabilization at various stages
c) Screened melt temperature and pH
d) Chemical dosing
e) Multibed filter in auto sequential mode
f) Brix control at melt concentrator
g) Pan station automation

8) Sulphur-less Sugar specifications

Colour	: Below 45 IU
Turbidity	: Less than 40 IU
Sulphur-dioxide	: Less than 5 ppm
Conductivity ash	: 0.02 to 0.03 %
Sediment	: Below 50 mg/kg
Polarization	: Above 99.5 %
Reducing sugar	: Below 0.04%
Moisture	: Below 0.04%
Beverage floc	: Negative

9) Advantages of Sulphur-Less sugar:

- Most important is to eliminate highly toxic Sulphur di-oxide gas thereby corrosive levels are negligible resulting into improved life of equipment with its piping and other adjacent equipments including building.
- 100% saving in sulphur cost and around 30-35% saving in lime cost.

- Reduction in cost for de-scaling chemicals.
- Good exposure for sugar to international market.
- Improved keeping quality as compared to sugar produced using double sulphitation process.
- Lower insoluble matter in final sugar due to removal of fine fibre particles during melt clarification and filtration.
- During the production of raw sugar and sulphurless sugar near-neutral pH is maintained thereby less risk of inversion loss and possibility of rise in recovery.
- White sulphurless sugar meets the various parameters as specified out by beverage manufacturers.

IV. CONCLUSION

Sulphur-less sugar production is beneficial for human, machine and atmosphere. This sugar gives higher premium. It is also a step towards refined sugar production. Hence now it is right time for our sugar industry to adopt this technology.

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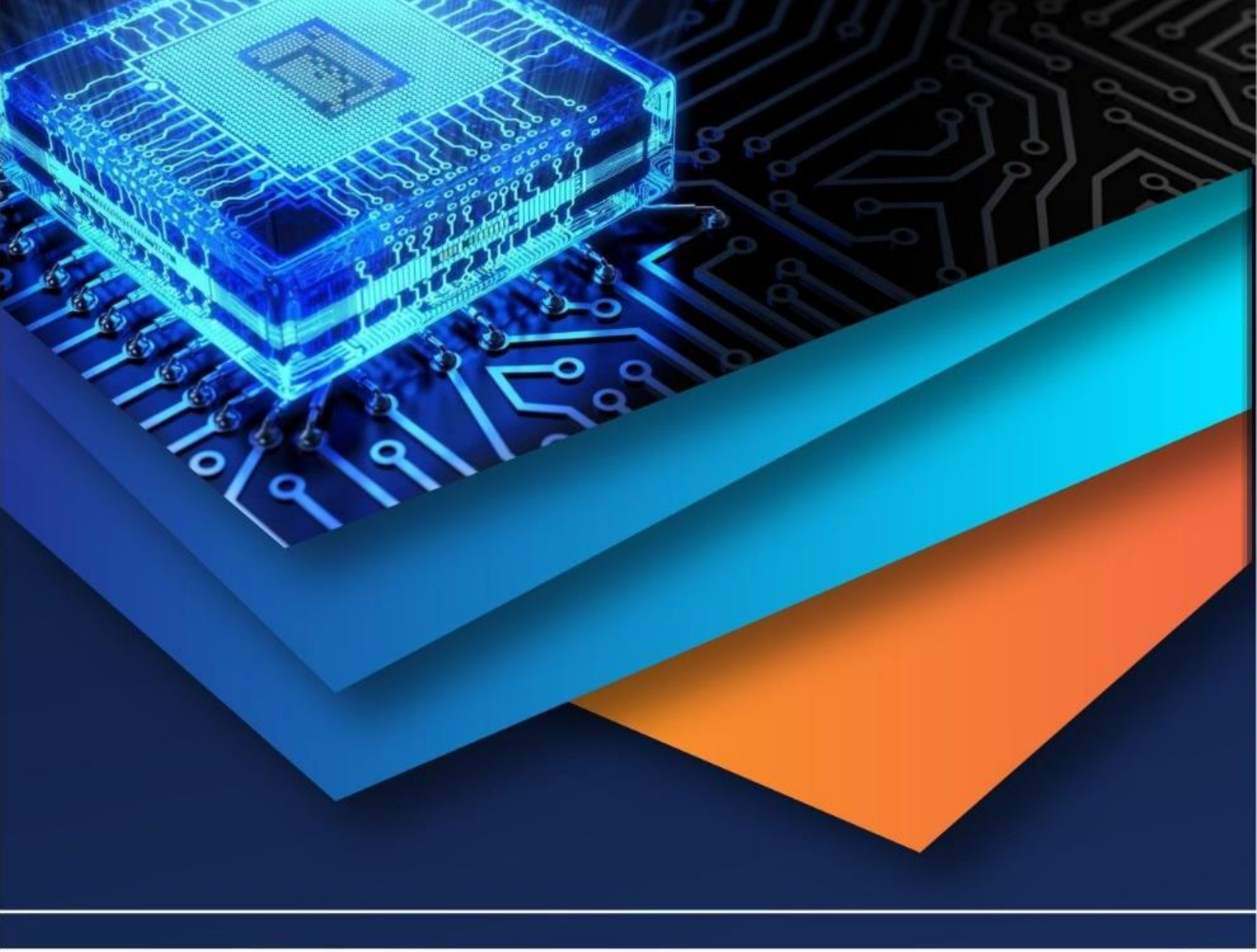

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