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Measures to Reduce Insoluble Matter in PWS Sugar

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ABSTRACT

Indian plantation white sugar has been improved in last two decade with respect to colour as well as ash %. However, still our sugar quality does not fulfil the criteria of insoluble matter. Due to higher insoluble matter in sugar, the soft drink manufactures have forced to follow clarification of sugar solution before their use. Various steps taken for reducing sediment in plantation white sugar such as reducing bagacillo in clear juice, preventing bagacillo at site, better flushing and residual scale removal while cleaning floating evaporator bodies, cleaning of syrup storage tanks for sludge removal, cleaning of syrup clarification units and vacuum pan internals, use of SS 409 lining to crystallisers/pugmill/magma mixer/sugar hopper, separation of powder sugar and its separate melting and filtration, controlling dextran formation, avoiding re-hoppering of sugar are discussed in this article.

Keywords : Ingrace of insoluble matter, fine bagasse particles, inorganic salts, corrosion scale, beverage and confectionery.

INTRODUCTION

Indian sugar industry has a greater awareness in terms of sugar quality parameters i.e. colour, ash % and insoluble matter in the sugar. In general, higher the insoluble matter, higher is the turbidity in sugar. As per National Soft Drink Association (NSDA) specification and Pepsi specifications, turbidity of sugar is limited to 20 R.B.U and 45 IU respectively. In many bottlers' specification, the sediment in sugar is specified below 2 ppm level. However, plantation white sugar produced in India contains higher insoluble matter. The sugar laboratory found insoluble matter in PMWS is ranging from 44 to 720 mg/kg in Indian plantation white sugar.

While analysing various sugar samples, author observed that the major constituent of insoluble matter in sugar is fine bagacillo. Generally, the upper layer of insoluble matter, ICUMSA Method GS2/3/9-19(2007)2 was used. The procedure of this method includes 500 + 1g OR 250 ± 1g sugar dissolved in 900 ml hot distilled water (45^{o}C) and filter through 8.0 um pore size Whatman membrane filter paper. Further, the membrane and the retained insoluble matter are thoroughly washed, dried and weighed. The insoluble matter content is calculated from the increase in mass of the membrane filter.

While analysing various sugar samples, author observed that the major constituent of insoluble matter in sugar is fine bagacillo. Generally, the upper layer of sugar does not contain bagacillo, but the central part i.e., nucleus of sugar crystal contains good amount of bagacillo. Possibly this bagacillo origin in sugar crystal is due to inclusion principle or due to growth of sugar crystal over fine bagacillo particle by assuming it as nucleus.

Insoluble matter in plantation white sugar. For improving plantation white sugar with respect to turbidity / insoluble matter, it is suggested to control clarifier operation and juice flow stabilization. In addition to this, reduction in bagacillo in mixed juice, judicious use of vibro screens at various points, syrup and filtrate

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clarification systems, online clear juice filtration system are also recommended.

Viswanathan et al. 2005, reported raw sugar melt is have to screen before sending to melt clarification, raw sugar screened on Vibro screen for removing bagacillo and other foreign particles yields in reducing insoluble matter/ turbidity for improving keeping quality of sugar. Clarke et al. 1998, noted that suspended solids in the sugar solutions (e.g. colloidal material) and high molecular weight soluble (e.g. Dextran and Starch) can come out of solution and enhance the appearance of Flock that has already formed. Londhe and Sidanale (2004) has studied various methods for turbidity measurement and concluded that turbidity measurement based on absorbance at 900 nm is seems to be simpler and more effective.

Major impurities in plantation white sugar

Sulphur Dioxide

Indian sugar industries follows double sulphitation process i.e. sulphur dioxide is used in combination with calcium oxide in juice clarification process as well as bleaching of syrup too. Calcium sulphite and hydrogen sulphite are occluded in sugar crystal lattice, during crystallization a thin film depositing on the crystals surface (Van der Poel, 1998).

In many countries the admissible maximum sulphur dioxide content in food products is fixed by law and therefore when sugar is used as a raw material in food and confectionary products, its initial SO_2 content is very crucial. Sulphite reducing bacteria transform sulphur dioxide into hydrogen sulphite, which is small concentrations can spoil taste and flavour of food products SO_2 content in sugar also favours the dissolution of tin and iron in cans.

Dextran

Dextran is present in sugar crystal when stale sugarcane is processed, which is responsible for formation of 'flock' in beverages. Though this parameter is not present in international specification of soft drink industry, it is recommended by Coca-Cola, India to monitor dextran on a continuous basis, in Indian processing conditions. The dextran content of sugar in majority of the mills was very high (even above 200mg/kg in summer months).

Insolubles

Substances present in white sugar as contaminants, which are insoluble in water, are of different particle sizes. Calcium salts and dust adsorbed from the ambient air are present as very small, fine particles. Coarser particles may consist of metallic fragments (rust), incrustations, carbonized organic particles, gunny bag fibers and bagasse particles (Van der Poel, 1998). As plantation white sulphitation process is not having any filtration, the insoluble level in Indian sugar is always high and when the sugar solutions are filtered before further industrial processing has marked negative impact on filtration performance. The insoluble matter is often considered as an important criterion as regards to the suitability of the sugar for direct consumption.

Turbidity

Water insoluble particles in sugar, which become visible as turbidity, not only affect the appearance of sugar solutions but are also responsible for unrefined / burnt / molasses type sensory attribute in beverages and food products.

Ash

It is an inorganic component that remains after complete incineration of organic substances. It mainly consists of potassium, sodium, calcium and iron cations and chloride, sulfate, carbonate and phosphate anions as well as sulfite and silicate. A significant correlation between inorganic constituents and sensory attributes has been found when sugar is used in beverages.

Microorganisms

Sugar that contain microorganisms can cause various difficulties when used in food processing industries e.g. mesophilic and slime forming in beverages, thermophilic in canning industry. In the confectionary and chocolate industries, gas forming bacteria as well as yeasts, those are contained in the filling, causes chocolate creams to burst and chocolate coatings to melt.

Colour

Colour of sugar shows undesirable impurities present in the sugar crystal. Higher colour is responsible for unrefined / mushy flavour of food products. Colouring matters in sugar also affect the appearance of the products. The browning properties of sugar on heating

are important for those branches of food industries which process sugar and impurities accompanying the sucrose, which essentially determines its behaviour during heating.

Iron

Iron catalyses the formation of brown colouring substances during the industrial use especially when being heated.

Measures for reducing sediment / insoluble matter in plantation white sugar

So author observed the major impurities present in plantation white sugar and their impact on sugar quality. During his work experience and the guidance of technical experts author concluded some preventive measures to reduce sediments/ insoluble in PWS.

Table 1 : Sediments / insoluble matter specified by different sugars types

Sugar type	Sediment range
Refined sugar	Less than 20 mg/Kg
PMWS	As per standard - Less than 150 mg/Kg Normal value – 70-300 mg/Kg
Soft drinks association	Less than 100 mg/Kg

To overcome the problem of sediment in sugar, following are authors suggestions in operation and design aspects

Measures to reduce bagacillo in sugar:

Juice screening: Juice screening plays a very important role in removing bagacillo particles. Usually single stage juice screening is practiced in the sugar factories. Further, Practicing double screening of raw juice and hot raw juice screening for reducing bagacillo in mixed juice effectively having a wedge slot size 0.35 to 0.2 mm.

Clarifier: It shall be operated by overflow and maintain consistent flow rate. higher turbidity/higher bagacillo in clear juice is caused by operating clarifier by liquidation. During low crush rate, provision for operating clarifier by overflow at 3rd or 4th compartment shall be made. Clear juice withdrawal coil design is circular in place of hexagonal with slope towards withdrawal point. Clear juice coil nipples size is less than 42 mm, nipple pitch have to be less than 500 mm, minimum 500 mm height in top compartment skirt and vent position clearance at top side is less than 5 mm, No intrusion of vent pipe in shell. For better results installing 80 mesh/100 mesh stationary screens or rotary screens gives best reduction of insoluble in clear juice (Londhe and Khandagave, 2021). These recommendation work is carried in Shri. Halasiddhanath SSKN, Nippani and gave best result.

Syrup clarification: Floatation type syrup clarification gives better result than other methods. Avoid ingress of bagacillo from atmosphere by covering the syrup clarification area and using of sealed cylindrical tanks of supply syrup / molasses.

General recommendations: Providing green net to all crystalliser top, take necessary steps for resisting bagacillo entry in pan and crystalliser station, providing covering to sugar hopper and provide vibro screens to screen bagacillo from melt.

Preventive measures for reducing crystallised scale in sugar:

Another important component of the sediment in plantation white sugar is settled sludge, often known as crystallized scale. The following strategies can help minimize silt caused by scale in plantation white sugar:

Evaporation station: The primary cause of calcium sediment in sugar is residue left over from cleaning the evaporator's floating bodies. In order to reduce the amount of calcium salt sediment, the cleaned evaporator body should be well flushed twice or three times after cleaning. The juice inlet coil to the body should have a slope on one side, a drain arrangement for flushed scale completely. And less dead space in the juice lines. It is recommended to conduct "boiling out of body" for five minutes after flushing and to remove all water.

Syrup clarification and syrup tanks: Practice syrup tanks cleaning within a fortnight. Separate scum de-sweetning system shall be installed to treat scum of syrup clarification system. Addition of undiluted scum in filtrate shall be avoided. Sulphited syrup temperature shall be above 65^0C to avoid crystallisation of scale and its settling in syrup supply tank. Retention of syrup at pan station shall be reduced less than 30 minutes. Pan suction line to syrup tank shall be at least 200 mm above bottom. Sludge settled in bottom portion shall be cleaned every 10 days. Necessary arrangement for cleaning each tank during crushing operation is to be made. Syrup tank shall be cylindrical and bottom shall have slope towards liquidation point for ease of cleaning/ liquidation. 75 % from top or use of fully covered syrup supply tanks.

General recommendations: After pan acid boiling, it must be well flushed. Sweeping sugar is also one of the major source of scale in the form of sediment. It is advised to gather all of the sweeping sugar for the season or month and melt it. Melt must be filtered through a vibro screen while being closely monitored. To separate scale or foreign debris from sugar or dry seed, powder separation from dry seed is highly helpful. Before adding the separated powdered sugar to the melt, it must first be heated separately and filtered through a vibro screen.

Preventive measures for reducing black particles in sugar:

In sugar dust and occasionally in sugar solutions, black particles are seen. Higher concentrations of black particles are typically observed in sugar crystals. The atmosphere is the primary source of black particles, which are unburned particles from malfunctioning boilers. Here are several suggestions to prevent this. Sugar hopper shall be covered to avoid falling of black particles from top, covering of open juice / syrup/massecuite storage equipment's and insalling fine filter to hot and cold air blowers

Preventive measures for reducing corrosion particles:

In plantation white sugar normally, MS is used in the manufacture of different types of equipment and tanks. Because the medium is acidic, corrosion occurs, ferric oxide is created, and this oxide eventually finds its way into sugar. These are the options to reduce this kind of sediment:

- In the off-season, thoroughly clean all bodies and vapour/juice piping systems. Apply corrosion-resistant coatings that are stable at 100 degrees Celsius.
- Within 50–60 days of operation, the inside shell of the pan will be cleaned using a high-pressure water jet.
- Crystallizers, massecuite gutters, pug mills, magma mixers and sugar hopper must be supplied of SS 409 liner thickness.
- Strong magnets must be employed at several locations, including the sugar cooling hopper, the sugar elevator feeding station, the sugar silo entry, and before the weighing machine.

Preventive measures for reducing starch and dextran in sugar:

Higher molecular weight compounds like starch and dextran are also part of sediment in sugar and to control this aspect following suggestions are recommended:

Milling station: Procuring good quality cane (matured, unburnt and low extraneous matter), minimizing cut to crush delay, physical cleaning of dead pockets at mill housing and juice gutters regularly, good mill sanitation practice, effective cleaning of rotary screen top and side shell.

Juice clarification: Regular cleaning of vacuum filter and accessories once in a day, cleaning of mud tank twice in a week, keep mud level 1 cock or below, use of exhaust steam for avoiding microbial growth in filtrate sealing tank and installation of filtrate clarifier with vibro screens.

Preventive measures for reducing extraneous matter in sugar:

Powder/dust sugar screening: Powder sugar contains high turbidity as well as higher sediment. The 50 % solution of powder sugar in water is very indicative regarding extraneous matter in sugar. All this extraneous matter shall be separated before feeding to pan. For this purpose, it is suggested to arrange baby melter for powder / dust sugar and prepare melt of 20-25 brix.

Table 2 : Quality specifications of different grades of sugars

Parameter	VHP	VVHP	PWS	Refined
% Polarization	99.40	99.63	99.5	99.7
% Moisture	0.06	0.04	0.05	0.05
% Ash	0.12	0.07	0.1	0.04
% Reducing sugar	0.13	0.07	0.1	0.04
% R.S. /Ash	1.08	1.00	-	1
Colour (ICUMSA)	800	427	120	<60
Insoluble matter (%)	250	150	15	<10
Starch (mg/kg)	237	125	-	-
Dextran (mg/kg)	<50	<50	-	-
Sulphite (mg/kg)	N.A.	Nil	<70	<15

VHP: Very High Polarization, VVHP: Very Very High Polarization, PWS: Plantation White Sugar

Table 3 : Quality specifications of liquid sugar

Brix	67.5-68
pH	6.5-6.8
Purity	99.9
Reducing Sugar	<0.5%
Ash	<0.5%
Colour	<25IU
Particles	<1
Yeast	<5/10ml
Mold	<5/10ml
Bacteria	<25/10ml
Flock Potential	No formation
Chloride	180mg/kg

Arsenic	<0.1mg/gk
Copper (Cu)	<0.1mg/gk
Lead (Pb)	<0.1mg/gk
Sulphite (SO3)	<5/gk
Iron	<1mg/gk
Quaternary ammonium compound	<2mg/gk
Sediment	<7mg/gk
Turbidity	<20IU
Mould	<5/10mg/gk
Bacteria	<25/10mg/gk
Odor	No off- odor

Table 4 : Quality specifications of pharma grade sugar

S. No	Description	Details
1	Sugar	99.9min.
2	Moisture	0.05% max.
3	Colour	10 IU max.
4	Insoluble material	5.0 max.
5	Ash	0.01 max.
6	Inverted Sugar	0.04 max.
7	Mean Grain Size	500um
8	Density	0.85 kg/lit

After melting, the melt of powder sugar/ dust shall be screened through vibro screen and screened melt is to be added in regular B melt or C melt.

Re-bagging of sugar: Many times, factories are practicing slightly damaged sugar reprocessing by way of rehoppering. Rehoppering shall be avoided because it increases bagging material threads in sugar and increases sediment.

Reprocessed sugar melt: It shall be screened for separation of threads / string/ packing material/ various pouches/sand, etc. from reprocessed sugar.

Sweepings to be collected: Is to be processed with filtrate or to be stored and to be processed once in month.

CONCLUSION

Awareness has been created in the sugar industries for production of plantation white sugar in terms of different quality parameters i.e. sugar colour, ash %, turbidity and insoluble matter in sugar. It plays a vital role to assess the quality factor in domestic and international market to fetch the value addition in terms of remuneration. So, to produce good quality plantation white sugar good process practices have to be carried out in order to meet the standard specification stipulated by the agencies. In this paper some important preventing measures are recommended which helps to reduce the insolubles and sediments in the plantation white sugar.

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