SUGAR QUALITY IMPROVEMENT IN INDIAN SUGAR INDUSTRY AND RECOMMENDATIONS OF ICUMSA

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ABSTRACT

The Indian standard IS:5982: 2003 (Revised Edition) for the plantation white sugar had specified 150 IU color. But for Export & institutional buyers like Coca Cola, Pepsi, Cadbury - The sugar color should be less than 100 IU & also other parameters like moisture, pol, ash, SO2 are varying from IS Standards.

It has always been a controversy in adopting the analysis method for sugar by various buyers & sellers. However ICUMSA has given various standard methods for analyzing various parameters to settled the issue. ICUMSA had made many modifications in analysis methods and techniques. In this paper an attempt is being made to focus on various factors affecting quality of plantation white sugar from user industry perspective and guidelines followed by Indian sugar industry to meet the day by day increasing expectation of user.
INTRODUCTION

In recent years, Indian sugar industry has achieved a remarkable progress in the production of good quality plantation white sugar by double sulphitation process & adopting various new techniques like clear juice filtration, Filtrate clarification and microfiltration and syrup clarification, Activated and granulated carbon treatment etc.

For production of excellent quality sugar Indian sugar Industry has taken some quality control steps at various station to produce low color & quality sugar. Emphasis is paid in areas of juice clarification process, Cane handling & crushing Management, pan boiling techniques.

Analysis methods recommended by International Commission for Uniform Methods of sugar analysis (ICUMSA) are widely accepted and used all over the world. Various analysis methods recommended by the ICUMSA are modified as per the advantages, accuracy & adoptability methods.
CHALLENGES BEFORE SUGAR INDUSTRY

Domestic market
- Stable per Capita consumption (17-19 Kg)
- Stable prices

Higher sugar production
- Storage
- Interest Burden
- Keeping Quality

Export
- Quality as per buyers requirement
- No government incentive
- Low international prices
REQUIREMENT TO OVERCOME CHALLENGES

To produce quality sugar to meet the requirements of Export, bulk consumers and institutional buyers Knowledge required –

• Role of sugar in the product
• Specifications of buyers
• Methods of analysis
• Knowledge about quality

Specifications: An explicit set of requirements to be satisfied by a material, product or service.

• Minimum: represent what is required more
• Maximum: represents what is not required and if present what is the limit
SIGNIFICANCE OF DETAILED SUGAR ANALYSIS

White Sugar – Considered unproblematic raw material for food Industry.
But ....

- Development of new technologies in the field of industrial sugar consumption.
- More awareness regarding nutrition, physiology & hygiene. Makes a necessity for detailed approach of white sugar quality.
ICUMSA is the only international organization concerned solely with analytical methods for the sugar industry. In addition to use by that industry, ICUMSA methods are recognized by authorities such as Codex Alimentarius Commission, the EU & the US FDA.

Objectives of ICUMSA:

1. To promote study of methods of sugar analysis.
2. International forum for all matters concerning methods of sugar analysis.
3. Interchange of information among the countries involved.
4. To publish Uniform Methods of Sugar Analysis.
ICUMSA METHODS OF COLOR ANALYSIS

- Color of sugar - Mirror of the quality Most important quality parameter Color analysis gives idea about –
- Total impurities
- Processing conditions
- Processing cleanliness
- GS 1/3-7 – For Raw Sugar & Speciality Sugar
- GS 2/3-9 – For White & Speciality Sugar
- GS 2/3-10 – For White & Speciality Sugar
- GS 9/1/2/3-8 – For all types of sugar including Plantation White Sugar

<table>
<thead>
<tr>
<th>Method</th>
<th>Solvent</th>
<th>pH</th>
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<tbody>
<tr>
<td>GS 1/3-7</td>
<td>Distilled water</td>
<td>7.0 With NaoH/Hcl</td>
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<tr>
<td>GS 2/3-9</td>
<td>TEA/HCl buffer</td>
<td>7.0</td>
</tr>
<tr>
<td>GS 2/3-10</td>
<td>Distilled Water</td>
<td>Natural pH</td>
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<tr>
<td>GS 9/1/2/3-8</td>
<td>MOPS buffer</td>
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## Indian Standard Specification for PWS, Refined Sugar & Raw Sugar

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<tbody>
<tr>
<td>1.</td>
<td>Loss on drying % by mass Max</td>
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<td>0.05</td>
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<td>2.</td>
<td>Polarization min</td>
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<td>99.7° Z</td>
<td>96.5° Z</td>
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<td>3.</td>
<td>Reducing Sugars % by mass Max</td>
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<tr>
<td>4.</td>
<td>Colour in ICUMSA units, Max</td>
<td>150</td>
<td>60</td>
<td>650-850</td>
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<td>-----------------</td>
<td>-------------------------------------</td>
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</tr>
<tr>
<td>5.</td>
<td>Conductivity ash % by mass Max</td>
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<td>0.04</td>
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<tr>
<td>6.</td>
<td>Sulphur dioxide .mg/kg Max</td>
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<td>15</td>
<td>20</td>
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<tr>
<td>7.</td>
<td>Lead , mg/kg Max</td>
<td>5.0</td>
<td>0.5</td>
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<tr>
<td>8.</td>
<td>Chromium µg/kg Max</td>
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## SPECIFICATION FOR EUROPEAN ECONOMIC COMMUNITY

<table>
<thead>
<tr>
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<tr>
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<td>Grade I</td>
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<tr>
<td>1</td>
<td>Pol (Min.)</td>
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<tr>
<td>2</td>
<td>Moisture (Max.)</td>
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<tr>
<td>3</td>
<td>Invert Sugar (Max.)</td>
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<td>4</td>
<td>Ash (Max.)</td>
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<td>5</td>
<td>ICUMSA (Max.)</td>
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## SPECIFICATION OF CODEX ALIMENTAREOUS & SOFT DRINK INDUSTRY

<table>
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<tr>
<th>SL.No</th>
<th>Particulars</th>
<th>Codex Alimentareous Commission</th>
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<td></td>
<td></td>
<td>PWS</td>
<td>WS</td>
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<tr>
<td>1</td>
<td>Pol % (Min.)</td>
<td>99.5</td>
<td>99.7</td>
</tr>
<tr>
<td>2</td>
<td>Moisture (Max.)</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>3</td>
<td>Invert Sugar (max.)</td>
<td>0.1</td>
<td>0.04</td>
</tr>
<tr>
<td>4</td>
<td>Conductivity Ash (Max.)</td>
<td>0.1</td>
<td>0.04</td>
</tr>
<tr>
<td>5</td>
<td>ICUMSA (Max.)</td>
<td>150 (10 Method)</td>
<td>60 (g Method)</td>
</tr>
</tbody>
</table>
FACTORS AFFECTING QUALITY OF SUGAR

- **PURITY**: Purity is sucrose content of sugar 100% minus ash, moisture and invert sugar. This parameter meets almost all specifications.
- **MOISTURE**: Formation of block or cake in storage, dissolution of sucrose in high relative atmospheric humidity, Development of microorganisms which split the sucrose molecule.
- **SULPHUR DIOXIDE**: SO₂ reacts as bleaching agent. Sulphur dioxide is converted into Hydrogen sulphide by sulphite reducing bacteria, resulting in deterioration. Hence in canning industry, where sugar is used, maximum permissible range is 20 ppm as SO₂ in sugar dissolves tin, iron etc spoiling the food packed. Hence judicious and efficient use of SO₂ is to be monitored.
- **INVERT SUGAR**: Mixture of two components of sucrose- D – glucose and D – Fructose
  - Invert sugars are responsible for promotion of Millard Reaction (Invert sugar + Amino acids and ash constituents) & affects the stability during long storage.
  - Method of analysis- ICUMSA GS 2-6 Modified Ofner Method
  - Permissible range of reducing sugars is 0.04 maximum.
FACTORS AFFECTING QUALITY OF SUGAR

- **CONDUCTIVITY:** Excellent criterion for sugar quality. The soluble ash is best indicated by conductivity, represents inorganic impurities, origin - Cane & Processing. Maximum permissible conductivity is 100µ mho determined on 5% sugar solution.

- **INSOLUBLE MATTER:** Insoluble extraneous matter in sugar affects its quality for industrial consumption as it reduces the rate of clarification & it is also hazardous from hygiene point of view. Source is Calcium salts, Dust, silica, hair, fibres, bagacillo, carbon, iron. Testing of sediments assesses the quality and also its source of contamination. Other than inorganic phosphates, oxalates & sulphates heavy alkali & alkaline earth metals like Sodium, Potassium, Magnesium, iron, copper, & toxic metals like mercury, cadmium, lead, manganese & zinc form the insoluble matters in sugar. Although they are negligible in quantity these metals affect the sugar quality as below.
DETRIMENTAL EFFECTS OF METAL IONS IN SUGAR & ANALYTICAL MEASURES AND SENSORY ATTRIBUTES IN BEVERAGES

- Toxicity: Pb, As, Cu, Hg, Cd.
- Elicitation of Sensory Characteristics: Mg, Na, K, Ca
- Metal Sulfides In Canned Food: Cu, Zn, Fe
- Destruction of Vitamin C: Cu
- Color Formation: Fe
- Increase in Conductivity Ash: All metals
- Increase in Buffer Capacity: All metals

- Analytical measures and sensory Attributes in beverages

<table>
<thead>
<tr>
<th></th>
<th>Unrefined / Burnt / Fruity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash</td>
<td>Unrefined / Burnt / Fruity</td>
</tr>
<tr>
<td>Chloride</td>
<td>Metallic / Salty</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Unrefined / Molasses / Fruity</td>
</tr>
<tr>
<td>Potassium</td>
<td>Unrefined / Burnt / Molasses</td>
</tr>
<tr>
<td>Sodium</td>
<td>Salty / Musty / Licorice / Metallic</td>
</tr>
<tr>
<td>Calcium</td>
<td>Fruity</td>
</tr>
<tr>
<td>Ammonium</td>
<td>Fruity / Green</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Unrefined / Burnt / Musty</td>
</tr>
</tbody>
</table>
FACTORS AFFECTING QUALITY OF SUGAR

- **Copper**: Source is cane juice, factory equipments with cupreous surface. Codex Alimentations Limit – 2 mg/kg, Coca Cola Specifications 1.0mg/kg max Affects food containing fat and phosphatides. Works as a catalyst in oxidation process of condensed milk products. Causes destruction of Vit. C resulting in discoloration of canned fruit and vegetables.

- **Iron**: Enters in sugar crystal from machinery especially in old plants. Affects keeping quality of sugar. Increases color in storage. Coke specification 1.0mg/kg max.

- **Turbidity**: Presence of fine particles of calcium sulfate and sulphite are responsible for turbidity, Increases cost on filtration of sugar syrup.
## MICROBIAL PROBLEMS IN SUGAR USING INDUSTRY

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Industry</th>
<th>Type of Microorganisms</th>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Beverage</td>
<td>Slime producers</td>
<td>Viscous &amp; slimy beverage</td>
</tr>
<tr>
<td>2</td>
<td>Soft drink</td>
<td>Yeast &amp; mould</td>
<td>Cloudy drink</td>
</tr>
<tr>
<td>3</td>
<td>Canning</td>
<td>Thermophiles</td>
<td>Souring, Bulging of cans</td>
</tr>
<tr>
<td>4</td>
<td>Chocolate</td>
<td>Bacteria &amp; yeast</td>
<td>Souring, Bulging of cans</td>
</tr>
<tr>
<td>5</td>
<td>Fruit Syrups, Sausages</td>
<td>Bacteria &amp; yeast</td>
<td>Microbial decay</td>
</tr>
</tbody>
</table>
GENERAL GUIDELINES FOR IMPROVING QUALITY OF PLANTATION WHITE SUGAR

A. Cane
B. Mill Station
C. Juice Clarification Station
D. Evaporation Station
E. Pan Boiling Station
F. Centrifugal Station
G. Sugar Gradation and Storage
CANE MANAGEMENT

- Maturity of sugar cane.
- Proper dressing of cane.
- The maximum removal of binding material.
- Remove top 2-3 internodes during harvesting for reducing color content in clarification process.
- The time duration between harvesting & crushing of cane is within 24 Hrs.
MILLING STATION

• Proper attention is to be paid on sanitation at mills.
• Washing of mills and mill accessories - twice in shift.
• Chemical Sanitation by using suitable biocides.
• Temperature of imbibitions water – 70 -80°C.
• Use of rotary screens.
• Bagacillo content in mixed juice is below 2 gram per liter mixed juice.
• The crushing rate should be maintained uniform.
JUICE CLARIFICATION

- Installation of automatic juice flow stabilization system.
- The insoluble particles i.e bagacillo in clear juice should be almost nil. The carry over bagacillo particles acts as nuclei for crystal development and such sugar gives higher insoluble matter in sugar and also increases color value of sugar.
- The phosphate level in mixed juice should be 300-350 ppm.
- Automatic pH control system will give better results.
- Follow shock liming method for juice sulphitation.
- Rise in CaO content from M.Jc. to Cl. Jc. Is minimum
- Operate the clarifiers preferably by over flow.
- Vacuum filters wash water temperature should be 65 – 70o C.
EVAPORATION

• No significant effect on quality is observed in the evaporators but the retention time of juice and uniform flow of the steam and juice is very useful in improving the performance of pan boiling and hence the quality of sugar.

• The exhaust steam temperature to 120±2°C positively. Addition of 15-20 ppm phosphoric acid in clear juice.

• The increase in color from clear juice to unsulphured syrup should be less than 10%.
Compared to any other station in boiling house, color development & increase of ash is more in pan station due to longer contact of sugar bearing mass with heat & high concentration, which promotes color formation.

For improvement of the quality of the sugar,
- Use of short tube length pans.
- Use of dry seed for footing.
- Reduction in boiling time.
- Maximum concentration of massecuite.
- Minimum recirculation of sugar & non-sugar.
- Use of hydrogen peroxide as pan aid.
- Production of small size sugar.
OPERATIONAL PARAMETERS

Vacuum at each pan should be 25”, as temperature of the pan is dependent on the vacuum.

The quality of the seed used for the A- boiling play important role in producing low color sugar. Higher the purity with low colour better will be the color of the sugar. If dry seed is used for seeding rather than B seed or C seed the colour of the sugar obtained is about 20 IU to 30 IU lower side. Recirculation of Sugar & non-Sugars yield higher color as well as ash % so recirculation of the sugar & non-sugar are to be avoided.
The use of super heated wash water (120°C) was found better as compared to steam wash.

Better attention needs to be paid to centrifugal maintenance.

1st wash water quantity should be kept as low as possible but 2nd water wash quantity may be kept little on higher side.

Use of live steam for seed melting should be avoided
SUGAR GRADATION AND STORAGE

- The temperature of sugar during bagging should be 36-38 Deg C.
- It is always preferable to use polythene lined gunny bags.
- It will be advisable to cover sugar hopper at safe distance with polythene paper to restrict foreign materials such as boiler ash, unburnt carbon etc.
- Use of Suitable dust catcher.
- Sugar Should be stored at low humidity of 65%
NEW TECHNIQUES IN THE IMPROVEMENT OF QUALITY OF SUGAR

There are no. of new techniques being tried for the improvement of sugar quality, few successful one are mentioned here.

1. Filtrate & Syrup clarification by Phospho flotation method
2. Melt clarification by Phospho flotation process
3. Clear juice filtration./ Filtrate filtration.
4. Ion Exchange process.
CONCLUSION

To produce sugar as per supplier expectation it is essential to have a fair idea of use of sugar in any particular industry and depth knowledge of various factors responsible for deterioration of sugar and user industry products.
I thankfully acknowledge CMD Of Triveni Engineering & Industries Ltd. Mr. D. M. Shawhney, Joint M. D. Mr. Tarun Sawhney, President (Sugar) Mr. A. K. Tanwar and VP(S) Khatauli Unit, Dr. Ashok for encouraging & allowing me to present this technical paper in International Sugar Conference-2011 New Delhi.
THANK YOU