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Effect of Ash Content on Color of Processed Cane Sugar

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Abstract

Samples from all three columns of the factory were taken at fixed time intervals and analyzed for color, pH and conductivity. Raw sugar, melt liquor, clarified liquor, filtrate liquor, de-colorized liquor and refined sugar; color, (ICUMSA) levels were found 727, 641, 335, 206, 80 and 50 respectively:; with a corresponding ash content of 0.17, 0.14, 0.13, 0.12, 0.11 and 0.10 . The conductivity ash was measured for A- sugar and found to be 0.12%, whereas the standard value is 0.1%. The obtained results showed that the ash content lied within the standard range. The high amount of reducing sugars cause or rise the color as it was formed at Assalaya sugar Factory. When, RS was 0.25 the color was 45 ICUMSA, but when the RS of the raw sugar was 0.77 the color appear as to be 776 ICUMSA

INTRODUCTION:

A semi-automatic instrument was developed for determination of ash content of white sugar. This instrument can be further developed to a fully automatic measuring device with the possibility of being connected to the process control system. Then measurement of color in solution can also be integrated [1] .

Affination is the main ash removal process in a phosphatation/ion exchange refinery. The amount of ash removed in affination is dependent on a number of factors; one of the most important being the quantity and composition of impurities in adhering molasses film. Ash impacts on the refining processes in a number of ways:

Ash components such as potassium and sodium increase the solubility of sucrose thus leading to increased sugar loss in molasses. Accumulation of high levels of chlorides in lower grade syrups can lead to stress corrosion cracking of centrifugal baskets. High sulphate levels can produce increased scaling in evaporators. High levels of sulphate ions can lead to reduction in Decolorization performance of acrylic and styrene resins.

Although their effect is often quite small this result is significant matched swith [2].

Despite increased effluent disposal problems, the lower capital and operating costs of fixed-bed ion-exchangers have caused them to replace activated carbon and bone char decolonization[3]. Sugar colorants are fixed to strong-base anion exchange resins by ionic bonding and/or by hydrophobic interactions.[4]investigated the removal of colorants by Rohm and Haas Amberlite 900 resin. Caramels are least retained by the resin, as they are relatively uncharged whereas the other colorants are anionic in alkaline medium [5] made a detailed study of fixed-bed decolorizing ion exchangers.

Color was measured by the ICUMSA color method. An analytic mathematical model was derived assuming no axial dispersion and constant linear isotherms. Model parameters were estimated from experimental data giving an average correlation coefficient of 0.91. Batch tests were also pertained to measure the equilibrium properties of the resin, expressed as an isotherm.

Langmuir isotherm was measured but in the concentration (color) range used, a linear fit was deemed acceptable. This model was used to improve the Tongaat-Hulett refinery in Durban, South Africa. The model does however; display the shortcomings of the ICUMSA color method on which it is based. An early breakthrough of a component that is strongly transferred to the crystal on crystallization could easily go unn. Another option is the removal of non-sucrose products from molasses. Glycerin and other products can be recovered from cane molasses stillage after the production of ethanol c showed that syrup rich in invert sugars could be separated from final molasses. Unlike, sucrose recovery, the above-mentioned processes were not affected by divalent cations in laboratory and pilot scale studies.

The economics of these processes is determined by the product prices[6].

Chromatography of refinery syrup is also possible. c showed that refinery syrup at 84% purity could be upgraded to 90% with 90% color removal and 96% invert sugar removal. Extensive testing has been performed on the chromatography of evaporator syrup prior to crystallization in the raw sugar mill [7]. The syrup must be filtered and softened (removal of calcium) prior to chromatography.

The chromatography upgrades the syrup to 98% purity and removes enough color to allow the direct crystallization of white sugar cc.

The mechanism by which sugar colorants are adsorbed onto a carbon surface may be divided into four consecutive steps:

1) Dispersion, 2) interparticle film diffusion, 3) interparticle diffusion, and 4) adsorption onto surface sites. The diffusion of the color compo- nents is a function of the temperature and viscosity of the sugar solution and the molecular size of the colorants [8]. Sucrose commonly known as sugar has an important in human life not only as an article of food but also as an ingredient of various medicinal preparations and even as a raw material for some products of everyday use. Sugar is thus consumed not only as sweetening agent in the human diet but also in pharmaceutical, food and other industries. Sugar which is formed by photosynthesis in plants from sun's energy is a natural food for all living beings. In the human system, when taken orally, the sugar is attacked in the stomach by hydrochloric acid of the gastric juices and converted into glucose and laevulose. In the small intestines these sugars are absorbed through the intestinal capillaries in the portal vein whence they are carried to liver and stored there. Sugar above a certain level in blood is converted into a polysaccharide known as glycogen. In view of its quick absorption in human system, place of sugar in every day diet in various forms is without any parallel. It enhances the natural flavour of fruits and is used in fruit canning in a big way. Sugar serves as a good preservative for editble products which can keep well in concentrated sugar solution for quite some time without deterioration. Fruit preservation and canning is a big industry in advanced countries of the world. It is widely used in beverages in tea, coffee etc. in most of the countries and forms the principal raw material base for candy as well as confectionery industries[9]. Colorants can fall into one of two categories: natural and those formed during production. Plant pigments: Plant pigments are inherent in the structure of the cane plant. They have been described as being primarily flavonoids and Phenolics[10]. They can comprise as much as two thirds of color in raw sugar. Flavonoids can be a considerable problem for sugar production, as they may account for 30% of the coloration of raw sugar at pH[11]. [12] reports that, due to their solubility, flavonoids can pass through the sugar production process without being removed. The inclusion of a glycoside in their structure causes an affinity for sugar crystals. Phenolics are generally uncolored until they undergo reactions with compounds such as amines or iron. Both Phenolics and flavonoids undergo

enzymatic oxidation reactions, which lead to process-formed colorants, described later. Plant pigments tend to have molecular weights of less than 1000 Daltons (Da). They are highly ionized, which gives them a high indicator value (IV, ratio of the absorbance at 420 nm of a sample at pH 9 to pH 4). They are readily removed during refining, but are also easily incorporated in the sugar crystal[13]. Contain more organic acid (pH 4.5) and when combined with lime during clarification, produce more calcium salts, (CaO), which effect formation of more scale in juice heater, evaporator, more formation of molasses and produce adverse effect on the colour of sugar canes, which have been injured or which are over ripe contain ordinary invert sugar as well. When sugar cane gets damaged by severe forest, all the buds are killed and the stalks split. The juice produced has lower purity, less sucrose, a high titrable acidity and an abnormal amount of dextran gum, all of which make processing difficult and at times impossible. [14]. White cane sugar is currently produced in three steps. The first step occurs in the sugar cane plant, where the sugar (sucrose) is produced. In the second step, raw sugar, which has a light brown color, is produced in a sugar factory (also referred to as a mill). The factory is ideally located in close proximity to the cane fields in order to minimize degradation and transportation costs. The third step occurs at a refinery, where the raw sugar is transported and processed to remove color and other impurities [15].

MATERIALS AND METHODS

2.1. Determination of conductivity ash for A-sugar:

The ash conductivity is a measure of the concentration of ionized soluble salt present in samples having conductivities of up to 500 us cm up at concentration of up to 5g 100 ml.

Principle:

The specific conductivity of sugar solution at a concentration of 5 g / 100 ml or less without the addition of sugar is determined 8.

Procedure:

The solution sample was prepared by dissolving 5 g of the sample in distilled water in 100 ml flask at 20°C. Then mixed thoroughly and it was transferred to measuring cell. The reading was taken. The ash conductivity was calculated using the following equation:

Conductivity Ash % = (162 +0,36 D) + 10-4 × C × f………….(3.7)

Where D is the dry substance concentration of the solution tested in g / 100 ml, is the mass of sample in 100 ml, C C1 is-G where the measured conductivity in Sem at 20°C and G is the specific conductivity of water, f is the dilution factor of solution in comparison with [5] 100 ml. f 5/s.

Ion exchange:

Two columns were used to examine the performance of an ion exchange system to decolor and demineralize the product from a carbon column. The strong acid action resin was Purolite C150, and the weak base anion resin used was Thermax Tulsion® A-2XMP. Both resins were soaked in deionized water for 24 hours to allow for swelling. 200 ml of SAC resin was added to the first column, and 240 ml of WBA resin was added to the second column. Since the resins were in the inappropriate forms (Na+ on SAC, Cl- on WBA), they were converted to H+ and OH- forms with HCl and NaOH solutions, respectively.The system was fed a juice mixture prepared from syrup produced at the Cora Texas Sugar Factory and de-ionized water. The color of the juice was raised from approximately 11000 IU to 22000 IU using final molasses from the same source. The juice had a final solids concentration of 18-20° brix. The carbon column was fed at rates of 15, 10, 6 and 3 bed volumes per hour (BV/hr), with the 15,10 and 3 BV/hr runs repeated with hydrogen peroxide dosing of 1000mg/kg on brix. The peroxide was allowed to react with the juice for at least 30 minutes. The temperature of the carbon column was maintained at 85°C by heated recirculating bath. The product of the carbon column was then fed to the ion exchange columns at a fixed rate of 3 BV/hr on the SAC column (200 ml bed volume). The SAC column was maintained at 10°C to prevent inversion of the sucrose in low pH conditions. The feed to the ion exchange columns was partitioned so that 3 BV/hr were fed to the columns with the excess being drained away. 1000 The media used in all three columns was chemically regenerated.

Carbon was regenerated using the NRP system, with 8 BV of the NRP solution being used. Temperature of the carbon column was controlled at 70°C during regeneration. SAC resin was regenerated with 4BV of 6% (v/v) HCl. BWA resin was regenerated using 4 BV 10% (w/v) NaOH. Resin column temperatures were not controlled.Samples from all three columns were taken at fixed time intervals and analyzed for color, pH and conductivity. Carbon column data were regressed on the model. The color data from the ion exchange columns were not regressed since the feed color was not constant.

RESULTS AND DISCUSSION

Ash content:

Former publications on this theme describe the theoretical fundamentals and automatic laboratory instruments. They do not describe possibilities of on-line measurements. One example is the development of a semi-automatic instrument for the determination of the ash content of white sugar. This instrument can be further developed to a fully automatic measuring device with the possibility of being connected to the process control system. Then the measurement of the color in solution can also be integrated [16] .

Affination is the main ash removal process in a phosphatation / ion exchange refinery. The amount of ash removed in affination process is dependent on a number of factors; one of the most important being the quantity and composition of the impurities in the adhering molasses film. Ash impacts on the refining processes in a number of ways:

Ash components such as potassium and sodium increase the solubility of sucrose thus leading to increased sugar loss in molasses. Accumulation of high levels of chlorides in lower grade syrups can lead to stress corrosion cracking of centrifugal baskets. High sulphate levels can produce increased scaling in evaporators and pans. High levels of sulphate ions can lead to reduction in de-colorization performance of acrylic and styrene resins. Although this effect is often quite small, this result is significantly matched with [17] results.

Table (1): Relationship between color and ash content

Sample	Color, ICUMSA	Ash
Raw sugar	727	0.17
Melt liquor	641	0.14
Clarified liquor	335	0.13
Filtrate liquor	206	0.12
De-colorized liquor	80	0.11
Refined sugar	50	0.10

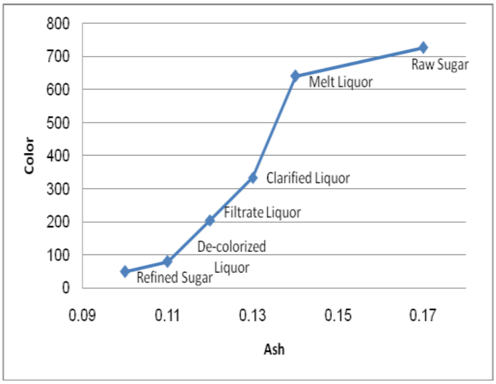

Fig (1): Relationship between color and ash content

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Appendix (1) Glossary

Brix: Percent day substance determined using hydrometer, refractometer or as derived from refractive index and reference to tables calibrated in term of percent stories by weigh in water solution.

Clarifier: A normal large-diameter tank used for settling suspended substances and for thickening settled mud obtained from defecated juice.

Imbibition: The process in which water of juice applied to dilute the juice present in the later.

Lover sugar: Combination of glucose and fructose formed in equal quantities by hydrolysis of sucrose.

Juice, primary: All juice expressed before dilution begins.

Juice secondary: The diluted juice which when mixed with the primary yields the mixed juice.

Juice nixed: The juice sent from the milling plant to the processing house.

Juice clarified: The juice entering the evaporator.

Juice limed: The juice obtained by addition of milk of lime to mixed juice.

Liming: Treatment of mixed juice with milk of lime up to p d 8.0-8.5.

Non-sugar: Any water-soluble matter, with is not saccharide.

Polarization: The amount of rotation given by an optically active substance to the polarized light when it vibrated around its axis under standard conditions (ICUMSA) expressed as equivalent sucrose and is treated pol.

Purity: The percent portion of pol in the Brix or gravity solids.

Reducing sugar: The reducing substances in the cane and its products calculated as in invert sugar, and they refer to reducing saccharides, which breakdown alkaline-copper reagents such as Fehling's solution and precipitate the copper.

Appendix (2) : Nomenclature

Bx Brix

Cj Clear juice

ICUMSA International Commission for Uniform Methods of Sugar Analysis.

ISSCT International Society of Sugar Cane Technology.

IU International Unit

M.j Mixed juice

P j Primary juice

Pol polarization

R.S Reducing sugar