The Parameters Affecting the Process of Sugar Drying - Assalaya Sugar Factory - Sudan.

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Abstract:

The main objective of this research work is to study the parameters that affecting, the process of Sugar particles drying to avoid the growing up of lumps in bagged sugar during Sugar storage Process. It is known fact that, every year considerable amount of sugar deteriorate during its storage in godowns, due to Sugar deterioration process, a huge amount of sugar bags comes from all Sudanese Sugar factories in process from sugar godown for reprocessing, which will increase the cost of the production. The most important factors contributing towards the deterioration of sugar in godowns is high temperature and moisture % Sugar at the time of bagging dampers in bags, which will contribute in lump formation , increase in color due to growing of bacteria. Parameters such as drying air volume, Cooling air volume, exhaust air volume, heating Surface, Steam Consumption ,Velocity of hot air ,Velocity of cool air ,Volume of Dryer and Retention time , were studied in this research work, the study proved that , the above mentioned parameters should be controlled to avoid Sugar deterioration process in godowns .

Keywords: Drying process, Sugar cane, Storage, Sugar crystals, deterioration process.

Introduction:

Sugar industry in Sudan was established in the early 1960s and currently, it is one of the most important hard currency earners that, contribute substantially to the national economy in terms of investment volume contribution to the total value of the national investment activities. The sugar commodity also, plays a significant role in the national Economy with locally produced sugar filling the gap of the sugar consumption and improving trade balance by refreshing the national economy. (Bushara and Abu Sin, 2016). In sugar factories, in order to produce the final product which is sugar in different grades, it is necessary, to control each part correctly, because the product of each cycle, will be supposed to be the raw material for the next step. So controlling each part of the process, monitoring of it and

evaluating the former product properties to be used in the later step, is a critical handle the whole process. During different processes which have been being done on sugar beet or sugarcane in sugar factory, Sugar is extracted as the famous product. Sucrose is disaccharide which is produced through many processes is in different kinds in market, such as: syrups or crystal sugar with different concentrations, qualities and purities. (Farrokhi et al, 2012). Sugar quality is the term applied to raw sugar to describe the chemical composition of the sugar and its fitness for the purchaser's intended use. More often than not, this involves refining to white sugar. The world market for raw sugar is extremely competitive and appropriate sugar quality is often the difference between making a sale or not, and the securing of a favourable price for the sugar sold. (e Library, 2000). There are many reports of problems caused by incorrect storage of sugar production - hardening, caking, dimming, losses and fires. Given the importance of crystal sugar, one of the main sugarcane based products in Latin America or around the World, there is a growing realization of work to increase efficiency and avoid losses in the manufacturing. However, during sugar storage, it is known that environmental factors (temperature, humidity, light and weather) influence the quality of the final product – several types of crystal sugars, such as: very high polarization (VHP); very high polarization (VVHP), and whites – Types 1, 2, 3 or 4. During storage, the temperature must be not exceed and/or sensitive to variations. The optimum relative humidity is 55-65% with the maximum equilibrium moisture at 65% (Aguiar, et al, 2015). Sucrose is the carbohydrate more interested in the processing of sugarcane, which is desired in crystallized form, and it is likely that the effect of temperature, enzymes and microorganisms is more important (Mantelatto, 2005). However during storage of crystal sugar, it is known that different environmental factors affect the quality of the finished product. These factors can be: temperature, humidity, presence of light, and the time, the period when the product is stored. According to Legendre and Clarke (Legendre and Clarke), the sugarcane juice color and therefore sugar originate from various compounds, such as Flavonoids, Phenolic compounds, and these pigments that react with reducing sugars, which affect directly the juice color and sugar quality. (ABIA, 2010). Sugar is the organic compound commonly known as sucrose. A white, odorless, crystalline powder with a sweet taste, it is best known for its nutritional role. Sucrose can be found in many medical dosage forms such as chewable tablets, syrups, lozenges, or gums. Sugar-

free formulations of many of these dosage forms exist as well. While sugar is essentially non-toxic, it can be associated with dental caries, exacerbation of diabetes, and weight gain. The molecule is a disaccharide composed of the monosaccharide glucose and fructose with the molecular formula $C_{12}H_{22}O_{11}$. (Touil and Ammar, 2017). Drying usually involves the removal of the relatively a small amounts of water or other liquid from solid or semi-solid material to reduce contents of the residual liquid to an acceptably low value. While evaporation involve the removal of relatively large amounts of water from solution. In evaporator the water is removed from the material as practically pure water vapor. In drying water is usually removed by circulating gas or air over the material in order to carry away the water vapor. (Peter,1993). Drying is usually the final step in a series of unit operations and the product from a dryer is often ready for final packaging. Water or other liquid may be removed from solid mechanically by presses or centrifuges or thermally by vaporization (Perry,1973) .The main objective of this research work is to study the Parameters Affecting the Process of Sugar Drying in Assalaya Sugar Factory-Sudan.

Materials and Methods:

Material:

The wet sugar sample used in this drying experiment was obtained directly from the sugar plant in Assalaya Sugar Factory- Sudan after centrifugation.

Equipment:

Assalaya sugar factory currently operates a cane sugar factory which produces Raw and refinery sugar, Two dryers were manufactured by jankins Dunford of UK for Fletcher smith who originally installed the factory. Most of the process information was obtained from Assalaya sugar factory and is included in the document the dryers were originally supplied in the 1978.

Data Collection from Assalaya Factory:

Case No I: Original Specification for Sugar Dryer:

a) Feed rate
25000 kg/hr (12500 kg/hr per each dryer)

b) Moisture content of sugar
feed 1.0%
Discharge 0.04%

c) Sugar temperature
feed 50^0C
Discharge 45^0C

d) Ambient temperature40^0C

e) Hot air inlet temperature.95^oC

f) Cooling air 35^0C

g) Heating medium Dry saturated steam at 3kg / cm^2

h) Electric Supply 415V, 3 phase, 50 Hz

i) Site elevation 430 masl. (Meter above sea level)

j) Drier size
Diameter 2.69m
Length 9.144m

l) Drum drive 25 hp 960 r/min Heaters one off 14,000 cfm from

40^{o}c – 90^{o}c one off 7,000 cfm from 40^{o}c – 90^{o}c

n) inlet fan Backward curve 17,500 cfm

o) inlet fan motor 50hp 1450 rpm.

p) Dust extraction fan paddle fan 22.000 cfm

r) Dust extraction fan motor 60hp 1450 rpm.

Case No II: Stated Capacity of 40000 kg/hr

a) Feed rate 40000 kg/hr per hour (20000 kg/hr per each dryer)

b) Moisture content of wet sugar 1.0%

c) Temperature of wet sugar in 50^{0}C

d) Moisture content of dried out 0.025%

e) Temperature of dried sugar 40^{0}C

f) Hot air inlet temperature 100^{0}C

g) Ambient temperature of air 45^{0}C

h) Cooling air inlet 30^{0}C

i) Drum diameter 2.69m

j) Drum length 9.14m

No III: Stated Capacity of 46000 kg/hr

a) Feed rate 23,000kg/hr

b) Moisture content of wet sugar 1.10%

c) Temperature of wet sugar in 50^{0}C

d) Moisture content of dried sugar 0.025%

e) Temperature of dried sugar out 40^{0}C

f) Hot air inlet temperature 90^{0}C

g) Ambient temperature of air 40^{0}C

h) cooling air 30^{0}C

i) Drum diameter 2.69m

k) Drum length 9.14m

Results and Discussions:

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Table 1- Show the result obtained from the drying operating condition from Assalaya Sugar factory- Sudan

Parameters	Standard	Raw sugar 12500kg/hr	Refine Sugar 20000kg/hr	Refine Sugar 23000kg/hr
Center fugal sequence	Automatic	Auto/ manual	Auto/ manual	Auto/ manual
Drying air volume	30000 m^3/hr	30000 m^3/hr	35000 m^3/hr	40000m^3/hr
Cooling air volume	30000 m^3/hr	25000 m^3/hr	35000 m^3/hr	40000m^3/hr
Exhaust air volume	65000 m^3/hr	60000 m^3/hr	75000 M^3/hr	85000m^3/hr
Heating Surface	Heating area	690m^2	790 m^2	795m^2
Steam Consumption	2-3kg/100kg of sugar	4.0kg steam /100kg sugar	3.80 kg steam /100kg sugar	5.7kg steam /100kg sugar
Velocity of hot air	limit (2 m/s)	1.85m/s	1.85 m/s	1.95m/s
Velocity of cool air	lower1.67m/s	1.76 m/s	1.6 m/s	1.6 m/s
Volume of Dryer	Q*1.35	16.875 m^3	2.065 m^3	21.06 m^3
Retention Time	14 min	21.87 min	13.67min	11.63min

Discussion:

It is obvious that volumes of cooling air required (especially during very hot periods) are far in maximum allowable air flow to maintain an expanded bed of sugar in the drier. To reach a dried sugar output temperature of 45^0C with the temperature of cooling air at $(42\text{-}45)^0$C would result in excessive cooling air flow; this high volume of air will result in the sugar in the cooling section being thrown up into the air causing excessive breakage of crystal. The retention time during raw sugar drying was found to be is very high 21.87 min, this large time decrease the capacity of sugar dryer acceptable. The Retention times for raw sugar in rotary Louvre drier is in the order of 14 min, this means that, there is ample room for increasing the capacity of the existing driers by changing the capacities of the fans and installing a chilling section to cool the cooling air . In order to achieve the desired capacity proposed for the new refinery the retention time in drier will be reduced to approximately 11.63 min for refinery sugar (which is still acceptable) by increasing the outlet temperature to an acceptable 45^0C . The observed Heating surface of air heating is rather large due to high humidity of air (bad condition of air source) , the air should not be heated to more than $(95\text{- }I00)^0$C $(203\text{ -}212)^0$F, or $lI0^0$C $(230)^0$F according to Tromp", in order to avoid damage to the sugar by the high temperature, it is arrange generally that the temperature of the air leaving the heater is between $(70\text{-}95)^0$C or $(158\text{ -}203)^0$F , the Rationalized Consumption of steam per quantity of inlet sugar is higher than stander ,this steam consumption is generally of the order of (2 – 3) kg/ 100 kg of sugar . The portion of the dryer serving as cooler should reduce the sugar to a temperature of $(35\text{-}40)^0$C or $(95\text{-}104)^0$F, that is due to less input sugar temp and poor performance of heating surface. Exquisite less of air velocity for incapable of heating and cooling air fans, the air velocity is in the range of (1-5) m/s, but it is reported that velocities greater than I m/s involve risk of picking up fine sugar crystals. In practice this speed is often taken up to 2 m/s or 6.5 ft./s, a limit which should not be exceeded, reckoned on the hot air leaving the dryer . The large reduction in the volume of cooling air means that the current exhaust fan, having a stated capacity of 60000 m^3/hr will require few modifications to achieve the outlet capacity of 80000 m^3/hr, if we need more capacity or low moisture content in final sugar product. If capacity of 20000 kg/hr is required through each drier, this may require modifications to the recently installed dust extraction, in dust extraction section the fan capacity should be increased to more than 60000 m^3/hr and the overall installation of the dust extraction system requires review. The most critical points the dryer and the crystal size all of the other parameters will depend on the equipment design and the operation of driers. If the capacity of the refinery is 20000 kg/hr the driers and the dust extraction plant

should be fully capable of producing good quality of dried sugar very few modifications to the existing dust extraction system would be required. From the process parameters provided by the Assalaya factory the flow of sugar to the driers could be well balanced with the availability of pans and centrifugal in operation, the centrifugal capacity in the factory is far in excess of the current production rate and there is a possibility that driers could be overloaded if the sequencing of the centrifugal is not correctly controlled. The feed through the bucket elevator and feed chutes is uncontrolled and although there is a surge bin prior to the drier it appears that, the screw feeder may have been removed in the past, the variable speed screw feeder should be reinstalled in order to feed the drier at a constant rate. The original design should have been to heat ambient air from the minimum temperature, this will mean that, on cooler days, in order will have sufficient capacity to cooler days, the radiators will have sufficient capacity to effectively dry sugar. In order to compensate for lower ambient temperatures, it the sugar, it would be around 65^0C the combined heating and cooling (which is now at 25^0C will then compensate for the lack of sufficient heating air. The driers are of sufficient size to effectively dry 20 ton/hr. The only restricting factors preventing the driers from working at full capacity are the heating and cooling fans and radiators. If the feed to the driers is constant and the sufficient capacity, the driers will comfortably dry sugar with moisture content of up to (1.1-0.025)% at an inlet temperature of between (55-65)^{0}C with an outlet temperature of (40-45)^{0}C.

Conclusion and Recommendations:

Based on the above results and discussions, it was observed that, Sugar deterioration phenomena was took place due to the uncontrolled parameters of the Sugar drying process, there for, we are strongly recommended to do, further studies to determine the optimum operating conditions of Sugar drying process.

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