Confidential

Manual for the control of sucrose losses in a sugar refining Process
(Part I)

To reduce sucrose loss by up to 1%

F O R W A R D

The contents of this Booklet represent many years of practical experiences. Apply these disciplines consistently and you will minimize losses. Deviate for a period of time and you will learn (as others have before you) the painful facts of higher sucrose losses.

Whenever a refinery finds itself running at a higher level than what it should be, it is interesting to note that no one single cause is ever found. Attention to detail and adherence to basic disciplines inevitably are applied. Then and only then does sucrose loss return to the plant's historical norm.

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I. INTRODUCTION

From an economic standpoint one of the most important and troublesome problems encountered in the refining of sugar is that of sucrose loss.

By the very nature of the process, due to processing conditions, some sucrose will be destroyed or lost. This is something which is inherent in the refining process, but by utilizing good refining practices, the destruction of sucrose and its loss can be held to a minimum.

Sucrose loss is expressed as a percent of melt and the standard for sucrose loss is determined by experience or historical performance of the plant. Anything in excess of this figure represent a variance from standard from which a dollar value is calculated. The actual dollar value for a given loss will vary from time to time depending upon the price of sugar, but in any case it represents a decrease in the company's profits.

Obviously then, it is imperative that in order to stay competitive, every effort must be made to minimize sucrose losses.

II. DETERMINATION OF THE SUCROSE LOSS

The refinery's sucrose loss is normally calculated on a quarterly basis, but if conditions warrant, it may be done at more frequent intervals such as monthly or bi-monthly, and it is always done at the time of a raw sugar cut-off. (See appendix for Raw Sugar Cut-Off)

The sucrose loss represents the difference between the kilograms of sucrose in the melt for the period being calculated and the kilograms of sucrose in the final products, including blackstrap, for that period adjusted for the difference in the sucrose in the stock-in-process at the beginning of the period being calculated and at the end of the period. This sucrose difference is expressed as a % of melt.

The stock-in-process referred to above consists of all materials in the refinery which were from the melt, but have not yet been recovered as production. The stock-in-process consists of liquid materials in tanks, filters or other equipment, fillmass in mixers and crystallizers, solid sugar in bins and silos and floor spillage. Since the amount of stock-in-process can vary widely from time to time depending upon operating conditions, it must be measured, sampled and analyzed at the close of each period for which the sucrose loss is being calculated.

When calculating the sucrose loss, the period covered, whether it be quarterly or any other period, is called the Technical Period and a Yield Statement is calculated for each Technical Period.

The Yield Statement is a balance sheet showing the input and output for the Technical Period. The input section shows the analysis of the raw sugar melted for the period and the kilograms of each constituent in the raw. The output section shows the analysis of all grades of sugar processed and the kilograms of each constituent. This output is adjusted for the difference in stock-in-process between the start of the Technical Period and the end of the Technical Period. From the difference between the input and output the % sucrose loss is calculated.

In addition to the sucrose loss, the yield statement contains other data which reflects operating conditions in the refinery during the Technical Period. Those involved in the refining process should become familiar with the Yield Statement and utilize the information therein as it applies to their particular phase of the operation.

The accuracy of the sucrose loss calculation for any Technical Period is dependent upon the accuracy of the data used to make the calculation. Errors in melt or production recording, non-representative samples, errors in analysis and inaccurate stock taking will be reflected in the calculations and will result in an apparent loss rather than an actual or true loss. This could result in the reporting of a sucrose loss higher than it actually is which is undesirable, but the greater danger is that it could go the other way masking a true loss and making the results appear better than they actually are.

III. TYPES OF SUCROSE LOSS

It is impossible to refine sugar without incurring sucrose destruction or loss. Every time a sugar liquor is heated, for example, some sucrose is destroyed. It is inevitable, and there is no way we can prevent it. There are also cases where we knowingly dispose of sucrose for economic reasons. When a desweetened carbonate cake filter for example, is turned to the sewer, sucrose is lost. In this case, the amount of sucrose is relatively small as compared to the amount of impurities and the volume of water that accompany it. And it becomes uneconomical to try to save the sucrose. These are examples, but there are other similar cases in the refinery. Such losses are inherent to the refining process, and it is in recognition of theses inherent losses that a standard for sucrose loss is set or a goal to attain.

More numerous, however, are places and conditions in the refinery where losses, which are not inherent in the process, can and do occur and these, by careful supervision, can be eliminated or at least held to a minimum. In order to recognize conditions, which promote sucrose loss and rectify them, it is necessary to understand the various types of sucrose lose and the conditions which promote them.

Sucrose losses fall into seven broad categories, but only three type is discussed as follows:

1 - Chemical losses
2 - Microbiological losses
3 - Physical losses

1- Chemical Losses

Chemical losses result when sucrose is changed chemically into something else. The two most common reactions are inversion and caramelization.

Inversion

In the inversion reaction the sucrose molecule is broken down into a molecule of dextrose and a molecule of fructose (also known as levulose). This combination of equal parts dextrose and fructose is called invert sugar. The changing of sucrose into invert sugar is undesirable because it represents sucrose loss. Invert sugar does not crystallize out in the vacuum pans, and it ends up as an ingredient in the blackstrap rather than 100% sucrose in a bag/product.

The inversion reaction depends upon the acidity of the sucrose solution. The acidity of a material is expressed as PH. On the PH scale, a PH of 7.0 is the neutral point. A PH value below 7.0 indicates acid conditions and the degree of acidity increase as the PH becomes lower. A PH above 7.0 indicates alkaline conditions and the degree of alkalinity increases as the PH value becomes higher. The inversion reaction takes place under acid conditions (PH below 7.0) and the lower the PH the greater the inversion. The rate and degree of inversion at a given PH depends upon several factors:

(1) Temperature - the higher the temperature the more rapid the reaction.

(2) Time - the longer the time the greater the degree of inversion.

(3) Density - the lighter the Brix the more rapid the Reaction.

To minimize inversion the PH of all liquors and syrups Must be kept on the alkaline side (over 7.0). this is done By adding milk of lime which is alkaline. On all of the important process streams there is a PH control system which monitors the PH and feeds into the stream the appropriate amount of milk of lime to maintain the desired PH level. Because the PH of sucrose solutions

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tends to drop, the PH must be adjusted at each step of the refining process. Generally, the PH control systems are set to maintain PH levels in the range of 7.8—8.0. This level is maintained for safety reason. If we were to maintain the PH at the 7.0 level and a malfunction of the PH control equipment occurred, the PH would drop below 7.0 before the malfunction could be repaired and inversion would take place, but by maintaining the higher PH level, we have a better chance of correcting the condition before the PH drops to the acid side and causes inversion. (See Appendix for rate of sucrose inversion.)

PH levels above 8.5 are undesirable since the color of a sugar solution increases as the PH increases. In addition, at extremely high PH levels some degree of sucrose destruction will take place.

Caramelization

Caramelization is the destruction of sucrose to form caramel, a brown colored substance which is undesirable not only because of its color, but also because of the destruction of sucrose which accompanies its formation. Caramelization is caused by heat and sucrose begins to decompose at approximately 190 ^{o}F. the higher the temperature, the greater the degree of caramelization.

In any tank or other piece of equipment where heating occurs, the heating element itself is above the caramelization temperature, thus although the average of the material in the tank is below the caramelization temperature, that portion of the material in direct contact with the heating element is above the caramelization temperature.
To minimize caramelization temperatures must be controlled and good circulation of the material in the tank maintained. Temperature controllers are set to normally maintain temperatures in the 175 –180 ^{o}F range on most materials in the refinery to minimize the caramelization reaction.

Caramelization is double trouble as far as sucrose loss is concerned. In addition to the sucrose destruction, the formation of color results in products which have to be remelted. The re-melting of any finished or partly finished sugars, in addition to causing excessive sucrose loss, results in excessive use of steam and reduces the melt. When the material gets reprocessed through the refinery, it is being subjected again to all of the critical areas with respect to sucrose loss thus doubling the loss. (See Appendix for caramelization.)

2- Microbiological losses

Microbiological losses occur when sucrose is destroyed due to the action of microorganisms, specifically yeasts and bacteria. A number of different types of microorganisms act on sucrose and their actions are varied. Some have the power to invert sucrose, some may break sucrose down into other products and most of them produce acid conditions as a result of their metabolism, thus setting up conditions for chemical inversion.

Microorganisms gain entrance into the refinery via the raw sugar which contains a variety of types in relatively high numbers. The refinery would be overrun by them were it not for several things. The size of the microorganisms is such that they are removed by press filtration providing, of course, that the filtration is tight. Most are killed at temperatures in excess of 165 ^{o}F and in most cases their growth is minimized at densities over 60 Brix.

The word “most” is used above because there are exceptions. There are certain bacteria, for example, known as thermophilic bacteria which can withstand excessive heat. When they encounter adverse conditions, they go into what is known as the spore state. The spore serves as a protective coating which protects them against heat, high density and serves as a protection against bactericides as well. While in this spore state, they will not grow or multiply, but they do not die. When conditions improve to their favor, they go back to their vegetative state and continue to grow and multiply. There are also yeasts known as osmophilic yeasts which can thrive in high density sucrose solutions.

Sweetwater, because of its low density and especially if it is warm, is an ideal medium for the growth or micro-organisms and severe damage can occur within a few hours. To minimize losses sweet water must be thickened up as quickly as possible by evaporation or by adding to some other heavy material. If it is necessary to hold sweet water for any length of time, it must be chemically treated by the addition of a sufficient amount of bactericide. Sweetwater should never be left over a weekend; by Monday many sucrose will be destroyed as a result of the microbiological action.

Sumps which handle sweet water are particularly critical. They must be kept clean and bactericide continually added to minimize microbiological action. Rotoclone sweetwater is also a particularly vulnerable material into which bactericide must be continually added to prevent micro-biological activity. Any puddles on the floor from leakage should be flushed to a sump quickly or chemically treated to prevent microbiological destruction. A small amount of contaminated sweetwater when added to a tank of good material can infect the whole tank in a short time.

There are certain visual evidences of microbiological activity. In Rotoclone ducts, for example, a gelatinous deposit known as “rope” indicates bacterial growth. In puddles of sweet water slimy, gelatinous spherical material known as “frogs eggs” also indicates bacterial growth. In a tank of sweet water bubbling and the odor of fermentation indicates microbiological activity. But one should not rely on any of these observations to determine whether microbiological activity is occurring since by the time these observations are noted, considerable damage has already been done. (See Appendix for dextran.)

Certain microorganisms produce enzymes which destroy sucrose. It is important to note that this enzymatic activity continues on after the microorganism is dead.

3. <u>Physical Losses</u>

Physical losses are those losses in which, as the name implies, Sucrose is physically lost. The sources of physical loss are many. In some cases sucrose can be sent directly to the sewer and lost. For example, if someone mistakenly turns a press filter which is on liquor to the sewer, it represents a physical lose of sucrose. Another example, if a pan or evaporator is allowed to carryover for whatever the reason, sucrose goes over the top and down the condenser to the bay.
The run-over of a tank or any other vessel represents a physical loss of sucrose. In the case of a run-over, no matter how diligently one is in cleaning up the mess, it is impossible to salvage all of the material. This is particularly true when it occurs on an upper floor and the material runs down from floor to floor coating walls, beams, stairways and anything else in its path. Even in the material which is salvaged some degree of loss occurs since it is converted into sweet water which is readily susceptible to loss.

Every leaking pipe, pump of valve represents a physical loss. One tends to consider these leaks minor in nature, but a number of such leaks can add up to a considerable amount of material lost over period of time.

Physical losses of sucrose are not limited to liquid products, they can occur in solid products as well. Excessive overweight, for example, on packaged products represent a loss. Damages which occur on the packaging lines and damages to bags in the warehouse also represent sucrose loss.

A wet floor, particularly the first floor, is a good indication of the degree of physical loss.

All out going sewers stream from the refinery must have sucrose detector.

4 - Responsibilities for Sucrose loss

The prime responsibility for the maintenance of optimum operating conditions, which will minimize sucrose loss, is that of the operating supervisors in the various area of the refinery.

Process operating specification must be established for the various materials in process in the refinery. In addition where PH, temperature or density control instruments are located, the appropriate specification ranges are affixed to the equipment for reference. If the process is maintained within the specification ranges for the various materials, sucrose losses will be minimized.

5 - Check LIST FOR Prevention of Sucrose Losses in Specific Refining Areas

(A) Raw Sugar

(1) Prevent physical losses of raw sugar resulting from Spillage at conveyors and dust creation at scale and Conveyors.

(2) Keep receipt scale and melt scale clean and in good Physical condition and test at frequent intervals to Assure accurate weighing.

(3) Keep raw sugar samplers in good operating condition and make sure lids are fastened down tightly on the containers to prevent drying out of the sample.

(4) Mix samples thoroughly and rapidly. Force sample Jars so that there is no head space and screw lids

On tightly to prevent evaporation.

(5) Arrange to melt as quickly as possible raw sugar Having a poor factor of safety or damaged raw.

(6) Control water sprays on discharge point and conveyors to avoid excess.

(7) Do not allow raw sugar to remain in contact with water! It causes inversion.

(B) <u>Wash House</u>

(1) Control Brix, temperature and pH of all materials Within specification range.

(2) Operate centrifugals within optimum parameters for the raw sugar involved and avoid overcharging.

(3) Keep sump clean and operating properly; maintain application of bactericide to sump during shut down, as directed by supervision.

(4) Avoid holding affination syrup, if any, or sweet water over the weekend of any prolonged shut down period.

(5) Discourage use of excess water.

(c) <u>Press Filters</u>

- Control Brix, temperature an pH of all materials

Within specification range; watch blowups particularly for excess temperature.

- Check presses for turbidity; switch any defective leaves into recycle promptly. Any earth passing through will decrease the effectiveness of the the processes down stream.

- Obtain maximum extraction of sucrose from the Mud cake; any remaining sucrose will be a loss .

- Keep sumps clean and operating properly and maintain application of bactericide to sumps.

- Discourage use of excessive water.

(C) <u>Carbon House, when applicable</u>

- Optimum revivification of the carbon in the kilns results in better color removal and minimize the necessity of recycling.

- Control revivification to provide optimum alkalinity in the carbon, where magnesium oxide is used .

- Settle carbon filters in a manner which will prevent channeling, will result in better color removal, better sweetening off and more effective washing.

- Sweeten off the filters as rapidly as possible and with a minimum amount of water.

- Wash to sewer a sufficient amount of time and at specified wash water temperatures to remove maximum ash constituents. Any ash left in the carbon will not be removed by revivification and will block up available pore area.

- Check to prevent wrong filter from being turned to sewer and check blow-down lines to be sure liquor is not going to sewer via this route.

- Keep quality of carbon up by removal of dust which slows filtration rate.

(E) Evaporators/Pan House

(1) Control temperature and vacuum at evaporators; Temperature of the first body of the sweet water evaporator (if there is one) is critical due to the thin density of the material.

(2) Prevent losses of sucrose to the condensers; sudden changes in vacuum at the evaporator, or operating too fast can cause excessive carryover. The "A" Liquor evaporator is very critical in this respect.

(3) Keep evaporator catchalls clean and inspect regularly; Any sugar past the catchall goes out the condenser.

(4) Check regularly for leaking tubes in evaporators; any Sugar entering the condensate is lost.

(5) Keep evaporators clean; scaled up evaporators

result in poor heat transfer.

(6) After boiling out or at startup after a shutdown, make sure sewer blanks are in place.

(7) Control Brix, temperature and pH of all materials within specification range.

(8) Boil pans according to established procedures-the Higher the temperature and the longer the time in the pan, the greater the chances of sucrose destruct-ion.

(9) Boil to a clean and uniform grain. This produces a sugar that washes better at the centrifugal, minimizing the necessity for remelting.

(10) Avoid mixing of syrups-this causes color problems.

(11) Wash sufficiently at the centerfugals to avoid color Problems.

(12) Avoid overcharging at centrifugals.

(13) Prevent drippage of syrup down from the centrifugals onto the wet oscillating conveyor below.

(14) In soft and remelt boiling it is especially important to boil according to established procedures. Due to the Longer boiling time and lower pH level, this mater-ial is more prone to sucrose destruction.

(15) Prevent loss of sucrose to the condensers; sudden

changes in vacuum or carrying the level too high in the pan can result in excessive carryover.

(16) Avoid drawing pan feed tanks empty—this will cause carryover.

(17) Clean storage tanks frequently.

(18) Keep catchalls clean and inspect regularly. Any sugar past the catchall goes down the condenser to the sewer.

(19) Run vacuum tests on pans to avoid changes in vacuum.

(20) Check regularly for leaks in the calandria; any sugar leaking into the condensate is lost.

(21) Keep pans clean; scaled up pans result in poor heat Transfer.

(22) After boiling out or at startup after a shutdown, make sure sewer blanks are in place.

(23) Operate crystallizers according to established procedure results in better extraction.

(24) Check regularly for leaks in cooling/heating elements In crystallizers--any sugar entering is lost.

(25) Boil soft sugars to proper color in pan. Do not rely on changes in spinning time at centrifugals to meet color specifications. This can result in rejections

and result in remelting.

(26) Keep sumps clean and operating properly and maintain application of bactericide to sumps.

(27) Discourage use of excessive water.

(28) Before boiling out pan, it must be empty of any sugar residue. Additional steam out is required prior to the boiling out procedure.

(F) <u>Finishing (drying and conditioning) House</u>

(1) Control granulator operation to achieve maximum dry-ilng—minimize the necessity of remelting.

(2) Check operation of rotoclones to prevent dust losses to the atmosphere.

(3) Check rotoclone ducts regularly for evidence of gelatinous material which results from microbiological growth.

(4) Prevent spillage from conveyors onto floor.

(5) Control temperature an pH of material in Sugar Melter.

(6) After boiling out or at startup after a shutdown make sure material is not turned to sewer.

There are other areas in the Finishing House where losses can and do occur. These are covered in the following under “Packaging Building” and “Syrup Manufacturing”

(G) Packaging Building

(1) Prevent wet or contaminated sugar from entering the silos.

Removal of sugar from the silos for remelting results in High loss.

(2) Prevent excessive dust formation in the conveying Systems.

(3) Prevent spillage from conveyors onto the floor.

(4) Keep all bin covers closed to prevent dust losses and possible contamination.

(5) Check dust collecting systems regularly to prevent dust Losses.

(6) Measure bin and silo stock accurately—a difference of a Few inches can mean several thousand kilograms.

(7) Control Brix, temperature an pH of melter within specification range.

Packaging (Items listed here apply to packaging operation in the Finishing House as well.)

(8) Keep all package weights within established specification Range—overweight represents physical loss.

(9) Prevent spillage at packaging machines.

(10) Maintain package quality-rejected packages result in re-processing.

(11) Check bulk car scales regularly-bulk sugar account for a Large percentage of the production.

(12) Carefully salvage the returns on bulk loads.

(13) Check truck scale regularly-all bulk truck shipment are Billed on this scale.

(H) <u>Syrup manufacturing and Shipping</u>

(1) Control Brix, temperature an pH of melter within specification range.

(2) Operate presses according to established procedure. If filtration is not tight, microorganisms will pass through And cause problems in the storage tanks which could Result in rejection and reprocessing.

(3) Operate evaporators according to established procedure. Off colored material due to heat could result in rejection And reprocessing.

(4) Prevent losses of sucrose to the condensers. Sudden changes in vacuum at the evaporators or operating at too high a level can cause excessive carryover.

(5) Keep evaporator catchalls clean and inspect regularly. Any sugar past the catchall goes down the condenser.

(6) Check regularly for leaks in calandrias of evaporators-any Sugar entering the condensate is lost.

(7) Keep evaporators clean-scaled up evaporators result in Poor heat transfer.

(8) Check operation of flash coolers-these can carryover too.

(9) Operate inverter according to established procedure. Out Of specification product could result in rejection and re-Processing.

(10) Check scales in Syrup Shed regularly--tank cars are billed on These scales.

(11) Check truck scale regularly--all syrup truck shipments are Billed on this scale.

(12) Check pumps in manufacturing and shed regularly for leaks at seals.

(13) Carefully control direction of sweetwater to the refinery.

(14) Keep temperature of wash water for trucks and cars within specification limits and wash trucks, cars and weigh towers sufficiently to sterilize. Microorganisms present could result in rejection and result in reprocessing.

(15) Check for condensation in the storage tanks-the water that accumulate on the surface of the material makes an excellent place for microbiological activity.

(16) Wash storage tanks when needed.

(l) <u>Warehousing</u>

(1) Prevent damage to packages on overhead conveyors. When this sugar trickles down from above, it is virtually Impossible to salvage it.

(2) Prevent damage to packages at palletizers.

(3) Prevent damage to bags by forklift trucks. Be especially careful in removing bags from storage racks.

(4) Inspect pallets carefully for nails or other defects which Cause bag damage.

Appendix

1) Technical management

Technical and process control to maintain consistent high efficiency

The primary objective of the Technical Division is to promote achievement of lowest manufacturing costs, maximum yields and satisfactory product quality through application of sound technical principles to efficient control of the refining process and allied operations.

This objective should be implemented with the following specific approaches:

1. To Initiate, participate, and contribute to new/improve processes
during the critical design and start-up phases.

2. Delegate responsibility and authority at refineries for achievement of maximum yields.

3. Establish local goals beyond set standards in order first to obtain them consistently,
and secondly not to be confined by their attainment.

4. Institute a means of advanced technical training for refining supervisors.

5. Insist upon refining supervisors (particularly the Refining Superintendent) keeping abreast of current technical

developments in sugar refining, through passion in reading sugar handbook, technical literature, regular contacts and associations with key technical organizations.

6. Avoid a trend toward mediocrity in technical performance by requiring technically trained supervisors to apply imagination and initiative in performance of their duties.

7. Institute local improvement projects (with a budget),

8. Introduce and use of new analytical and evaluation techniques (i.e., modern statistical approaches).

9. Use Process Technologist for process improvement instead of solely for trouble shooting or vacation replacement.

10. Avoid conflicts with other programs which prevent refineries from making yield standards, by having closer liaison with Central Engineering, and refinery organization regarding process changes.

11. Improve sugar refining by demanding technical understanding and initiative instead of primary reliance upon “trial and error” and the “cook book” approach.

12. As soon as possible, initiate fundamental sucrose loss Technical Control Program.

13. Strive for standardization of the refining processes.

14. Improve inter-division communications, so technical problem can be anticipated.

(I) Specific Function of the Central Technical Department

1. Control sucrose loss
2. Maximize blackstrap molasses exhaustion
3. Improve process efficiency
4. Process improvement and development
5. Raw sugar quality criteria and testing
6. Product specification and governmental compliance
7. In-coming material specification and governmental compliance
8. Standardization of analytical methods (UMA)
9. Analytical methods development
10. Trouble-shooting and customer complaints
11. Up-date sugar technology
12. Other

(II) Technical control and management

1. Technical audit
2. Raw sugar yield audit

3. Trouble-shooting of process problems

4. Seminar on technical quality control

5. Seminar on process technologies and operations

6. Monitoring of technical and quality control parameters

7. Monitoring of operating parameters for process efficiency

8. Central analytical laboratory

9. Other

(III) Technical audit with the objectives

1. To examine each process based on best known practice and best
available refining technology within the sugar refining industry

2. To make recommendations that will minimize sucrose loss, review
blackstrap purity and improve process efficiency

(IV) Raw Sugar yield audit

1. Raw sugar receipt

2. Raw sugar melt

3. Stock-in-process inventory

4. Refined stock inventory

5. Production

6. Handling of returns

7. Handling of reprocessed/repacked sugar

8. Product transfer

9. shipping control (scales, invoices, etc.)

10. Preparation of yield statement

(V) Central Analytical Laboratory

1. Raw sugar testing

2. Testing & experiments involving:

   Process trouble-shooting
   Process improvement
   Process development
   Raw sugar quality criteria

3. Customer complaints involving potential liability

4. Testing of in-coming material & in-process material

5. Analytical method development & UMA

6. Specialty testing:

   AA, IR, GC with ECD, IC, HPLC

2) – Rate of Sucrose Inversion

The inversion of sucrose has been studied by many investigators. The results between investigators vary slightly but are not significantly different. One of the most comprehensive studies was performed by Dr. K. J. Parker of the Tate and Lyle Sugar Company in England, the results of which are shown below:

PERCENTAGE OF SUCROSE INVERTED IN ONE HOUR

		pH				
C	BRIX	5.0	5.5	6.0	6.5	7.0
60	10	0.050	0.016	0.005	0.0016	0.0005
(140 F)	60	0.025	0.008	0.003	0.0008	0.0003
	70	0.019	0.006	0.002	0.0006	0.0002
	80	0.012	0.004	0.001	0.0006	0.0001
70	10	0.16	0.052	0.016	0.0052	0.0016
(158 F)	60	0.083	0.026	0.008	0.0026	0.0008
	70	0.062	0.020	0.006	0.0020	0.0006
	80	0.039	0.012	0.004	0.0012	0.0004

80	10	0.45	0.14	0.045	0.014	0.0045
(176 F)	60	0.25	0.079	0.025	0.0079	0.0025
	70	0.18	0.058	0.018	0.0058	0.0018
	80	0.12	0.036	0.012	0.0036	0.0012
90	10	1.26	0.40	0.13	0.040	0.013
(194 F)	60	0.69	0.22	0.069	0.022	0.007
	70	0.51	0.16	0.051	0.016	0.005
	80	0.32	0.10	0.032	0.010	0.003

3)– Caramelization

In the foregoing discussion it was mentioned that caramelization is the destruction of sucrose to form caramel, a brown colored substances. To be more specific, sucrose breaks down with heat into a number of compounds some of which result in color formation while others do not produce color. Those, which produce color, are referred to as caramel or caramel type products. The breakdown of sucrose is complex as is shown in one of the attachments

4)– Dextren

A major source of sucrose lose due to the action of microorganisms is the formation of dextrans. The slimy gelatinouse material sometimes found in dust collectors and the "frogs eggs" found in sweetwater is dextran. It is sometimes referred to as "leuconostoc growth" because it is formed by a family of microorganisms called Leuconostoc bacteria.

In addition to the loss caused by the destruction of sucrose, dextran is undesirable for other reasons. Dextran increases viscosity creating problems in evaporators and pans. It also causes elongation of the sugar crystal making purging at the centrifugals difficult. It also gives artificially high polarization values. Each 330 ppm dextran raises the polarization by .1.

5) Pathway of sucrose degradation.