RAW JUICE CHROMATOGRAPHIC SEPARATION PROCESS (ASSBT 1995)

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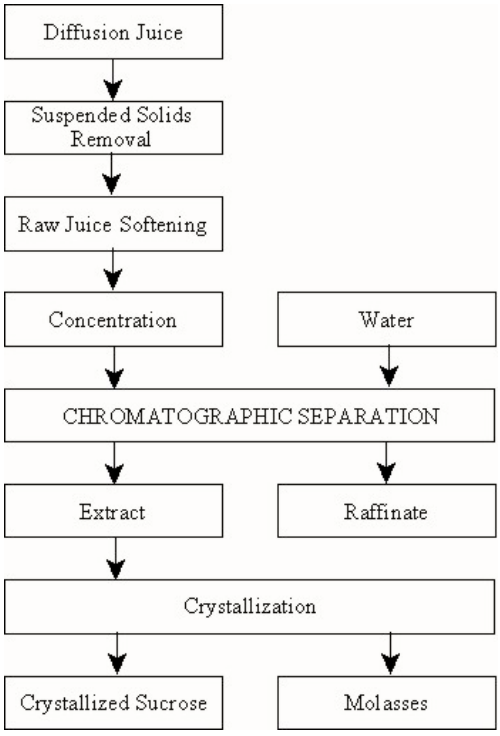
The raw juice chromatographic separation process has been developed by The Amalgamated Sugar Company with several goals in mind. These goals include: elimination of liming and carbonation, elevation of extraction levels, alleviation of pollution concerns, reduction of sugar end handling requirements and an overall simplification of the beet sugar production process.

In general, the new process (patent pending) consists of preparing raw juice for use as a separator feed, treating the prepared raw juice through a chromatographic separator and crystallizing sugar from the separator extract. Products from the process include crystallized sucrose, a concentrated nonsucrose by-product, and molasses.

The process has been tested in its entirety on a computer controlled, 7 day/week, 24 hour/day pilot plant. The plant has operated continuously and in parallel with the Twin Falls factory operation for two campaigns. In general the process can be outlined as follows:



Raw juice is obtained in the usual manner via diffusion. Suspended solids must be removed from the raw juice in order to prevent plugging and pressure drop in the softener and the chromatographic separator.

Extensive pilot tests with raw juice have demonstrated the practicality of several softener configurations. In the early 1980's Amalgamated Sugar studied both weak and strong cation softening as a prerequisite for chromatographic separation of molasses. These studies included both high capacity acid regenerated weak cation and raffinate regenerated strong cation softeners. With minor modification, both systems have been found to be transferable to the softening requirements of raw juice. Both of these softening systems are pollution free.

With respect to softening, raw juice exhibits characteristics quite different from thin juice. A softening advantage with raw juice is that hardness levels do not change with deterioration of beets since hardness is never added in a liming and carbonation procedure. Hardness levels are therefore essentially constant and predictable throughout campaign.

A disadvantage with raw juice is that the incoming hardness levels can be quite high so softener design capacity is critical. Another interesting factor is that the hardness in raw juice is primarily magnesium rather than calcium.

Following softening, the raw juice is concentrated to a level proper for feed to the chromatographic separator or for temporary storage. The “soft raw syrup” is a very handleable material and our tests have demonstrated up to one year storability.

The concentrated soft raw syrup is fed to a monovalent form chromatographic separator along with water as an eluent. The purification across the separator is very high. Typically, 75-85% of raw juice nonsugars are removed by the separator. This includes 95% of the charged compounds and 95% of the color. High molecular weight compounds such as dextran are 99%+ eliminated.

The by-product raffinate contains the majority of the raw juice nonsugars and is somewhat similar to raffinate obtained from molasses separation. This material is usable as an animal feed and can fill the same role as concentrated raffinate from molasses separators.

Specific details of component separation are presented in a separate A.S.S.B.T. paper[1].

The product extract is sent to the sugar end for crystallization of the sucrose. Due to the very high purity of the extract, the sugar end operates in a manner similar to a cane refinery wherein several white pans in series are employed and very little low purity fillmass and molasses are produced.

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[1]Non-sugar removal in the molasses and raw juice chromatographic separation processes”, D. Eugene Rearick; paper presented at A.S.S.B.T. 28th General Meeting, March 1995.

The following lists several of the benefits and unique characteristics of the raw juice chromatographic separation process.

1. The raw juice separator eliminates the entire liming and carbonation purification system.

   Eliminates the lime kiln.

   Eliminates all preliming, mainliming, first and second carbonation.

   Eliminates the lime waste.

   Eliminates the need for a lime pond or other lime disposal procedure.

   Eliminates associated power requirements.

   Eliminates support equipment (tanks, pumps, filters, controls, etc.).

   Reduces noxious factory odors because the reactions which form these compounds in liming and carbonation do not occur.

   With liming and carbonation about 15 to 30% of raw juice nonsugars are lost to waste lime. With the raw juice separator the eliminated nonsugars become a saleable by-product.

   Environmental problems associated with firebrick disposal are eliminated.

   Hazards associated with handling of limerock, powdered lime and CO_2 are eliminated.

   First and second carbonation vent emissions which are of environmental concern are eliminated.

   The raw juice separator process reduces ammonia as a pollutant. The new process maintains conditions which attenuate the decomposition of glutamine.

   The factory will be visually cleaner inside and out.

2. The raw juice separator yields a much higher level of juice purification and sucrose extraction compared with liming and carbonation.

   Typically 75-85% of the raw juice nonsugars are eliminated across the raw juice separator. This is without the use of any chemicals.

The high nonsugar elimination results in a very high extraction. The increase in extraction from beets is typically 10 points over that obtained with conventional liming and carbonation purification.

In the conventional system the same nonsugar is treated over and over again through various purification systems (liming and carbonation, crystallization, optional molasses separation and second pass crystallization). With the raw juice separator the nonsugars are treated about one-half as much, since the majority is eliminated in the first purification.

3. Operational consistency is very favorable. As beets deteriorate, little change in processability or extraction is observed with the new process. Acids and high molecular weight compounds in deteriorated beets are easily removed by the separator.

4. The raw juice separator produces a very high quality product.

   Separator extract is typically 97-99 purity.

   Separator product is nearly deionized (80-95% K^+, Na^+, and other inorganic and organic salts are eliminated).

   Color is 95% eliminated across the raw juice separator.

   Without carbonation, no off-odor carbonation compounds are formed and the separator removes raw juice odors so all syrups and crystalline products subsequent to the separator are free of odor. The crystalline sugar has a very pleasant sweet odor which is different and cleaner than conventional sugar.

   The separator removes off-taste material (such as bitter potassium compounds) so sugar is free of off-taste. The resulting syrups, greens, fillmasses, and sugars are quite palatable.

5. Because of the high nonsugar elimination, the raw juice separator significantly reduces sugar end quantities handled for equivalent crystalline sugar production rate.

   10-30% less white fillmass.

   60-75% less high raw fillmass.

   70-80% less low raw fillmass.

   70-80% less molasses.

   Similar percentages of equipment and resources can be eliminated from the sugar

end and/or advantage can be taken of the extra resources.

Most of the high raw and low raw sugar are eliminated so nearly all the sugar-end internal nonsugar recycle is eliminated.

Pan and crystallizer time can be significantly increased on the low end.

Because of the high level to which Na^+, K^+ and other salts are eliminated, the molasses exhibits very low sucrose solubility. Solubility expressions indicate about 43 purity molasses can be expected with typical nonsucrose/water ratios. Due to the consequent low loading of crystallizers (long retention time available) and favorable solubility characteristics, both thermodynamics and kinetics contribute to excellent molasses exhaustion.

6. The factory process is simplified because of the elimination or reduction of both beet-end and sugar-end equipment.

Conclusions:

The Raw Juice Chromatographic Separation Process has been demonstrated in extensive pilot testing to be a viable alternative to conventional liming and carbonation purification. The process is superior with respect to extraction, chemical use, pollution concerns, beet end equipment requirements, sugar end material handling requirements and processing consistency.

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