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More on Clarification

As I wrote last month, cane juice clarification is, in principle, a simple process but, as always, the devil is in the details, especially if the cane being processed is of poor quality, for whatever reason. The ability to respond to changing conditions can be important if the cane quality is variable but there is the risk of overcomplication of the process if the juice treatment is not robust enough to take care of most cane conditions without changing the chemical treatment of the juice. Adequate heating and flashing of the neutralized juice are always essential and variation in the chemical treatment is the primary variable that the sugar technologist can use. Many chemicals have been tried and there is an extensive list in the 6th edition of the Cane Sugar Handbook. Very few of these materials would even be considered now, with our concerns about food safety and adulteration. Imagine using creosote in food production!

The goal should be the minimal use of simple, safe and inexpensive chemicals and both laboratory testing and economic analysis should be performed before applying costly "special" chemicals. Jar tests can be useful as the means to eliminate unsuitable materials but are not sufficient to prove utility – only full scale plant trials can do this. If a chemical vendor wants a cane processing facility to test a new product, I would expect the vendor to be very open with information on the material and its proposed mode of application and function. There is no magic in this business!

The general goal of cane juice clarification is removal of sufficient suspended solids and colloids to be able to produce a raw sugar with satisfactory refining characteristics. Juice clarity is an important but not overwhelming factor – the ability to separate the precipitated mud from the clear juice in the clarifier is at least as important. Neutralization with sodium aluminate or sodium carbonate, replacing lime, can work some of the time. In the aluminate case, if used to replace all the lime, the juice clarity is excellent but the floc are very light and do not settle. Low doses of aluminate are used to supplement the lime treatment and this can work well. Settling rates are determined in part by the density (brix) and viscosity of the juice being clarified. I have heard suggestions that dilution of the clarified juice will improve operation and simple calculations indicate that reduction of juice brix by two points should increase the settling rate by 5 to 7%. This does not make much sense since the additional water has to be evaporated and the increased volumetric flow of the juice required to maintain the grinding rate would offset the benefits of faster settling.

Over and above the use of lime and flocculants, other chemicals can be used to enhance clarification. Phosphate deficiency in raw juice can be dealt with by addition of phosphoric acid or phosphate salts prior to liming. Phosphoric acid is generally preferred since no additional cation is added. The chemical reactions of clarification remain the same. Sulfur dioxide is used in sulfitation processes to enhance clarification and reduce juice and syrup color to give low color direct consumption sugars. Some of the impacts of sulfitation, such as viscosity reduction, are well appreciate if not fully understood. These approaches are well established but other treatments are more problematic, such as the sequential use of cationic and anionic polymers. For this to work, there needs to be balance between the dosages of the two materials and this can be difficult to achieve. Further, secondary clarification steps have been proposed to improve the quality of the clarified juice, for example, electro-coagulation. As well as the additional equipment involved for such unit operations, these approaches undermine the essential principle of keeping the process simple – the more variables involved, the more complicated and uncontrollable the process becomes.

Dirty cane (with field soil) increases the quantity of insoluble solids to be removed at clarification and the quantity of filter cake, but may have relatively little impact on clarified juice quality. There are data that suggest that clays in some soils may have a beneficial impact on clarification. One of the traditional clarification aids was bentonite, an aluminosilicate clay.

Measurement of purity decreases across the clarification system should be made on a regular basis. There should be no more than two purity points difference between the clarified juice and the filtrate from the rotary vacuum filters. If this difference is greater than two then the purity of the muddy juice from the bottom of the clarifier should also be measured. Loss of sucrose due to inversion and micro-biological activity can occur in the mud held in the clarifier and in the mud handling system. It is valuable to identify the location where most loss is occurring.

Filtrate clarification may be justified if factory throughput is greater than the clarifier capacity when filtrate is routinely returned to the limed juice tank. The alternative would be installation of additional clarifiers or, better, modification of the existing clarifiers to allow more rapid removal of juice through improved internal take-off piping which reduces turbulence inside the clarifier. But we must always be wary of adding equipment or making modifications to solve a problem without really appreciating what the problem is. Simple operating solutions are rare but the first parameter to investigate is the solids retention at the filter. If poor (< 75%) this can be significantly enhanced by good mud conditioning using bagacillo, flocculants and pH adjustment with lime if necessary. A difference in pH between filtrate and clarified juice is irrelevant if the filtrate is returned to the limed juice tank. However, if the chemical conditions, e.g. pH, for filtrate clarification are different from the main clarification, then combining them prior to evaporation may induce further precipitation and/or increased evaporator scaling.

In any purification system, the real challenge is not in getting clean material but in handling the dirty end. Some thoughts on this next month.

SJ