

Question Authority

I saw the title for this month's column as a bumper sticker on a pick-up truck when I was walking through our neighborhood. The sugar industry, a mature industry with long established and successful operating practices, has a tendency to resist change. This is not to say that the industry is static and not advancing in capacity and efficiency, but recent advances are based more on automation and control of the established processes, rather than changing these procedures. As I have written before, the raw material, cane, remains the same and the product is the same. What we need to think about is alternative ways to get from the beginning to the end.

One of the problems is that a large body of industrial theory and practice has become established and to quote Robert Conquest (an English poet and historian) – "Generally speaking, everybody is reactionary on subjects he knows about." Contrast this with Emerson's – "A foolish consistency is the hobgoblin of little minds, adored by little statesmen and philosophers and divines. With consistency a great soul has simply nothing to do." (I have included the complete quotation – much more interesting than just the first part.) There have been extraordinary sugar technologists, for example Noel Deer, and there is a tendency to accept without question what they have proposed. Further, simple explanations are too easily accepted, without appreciation of the inherent fuzziness of measurements and operating systems.

There has been considerable recent discussion on the sugartech web of the subject of reduced extraction and mill balances in general. Reduced extraction may be a useful comparative figure but is much less important than having good data for the mill that is the individual engineer's responsibility. The standard weight relationship (cane + water = juice + bagasse) is an oversimplification at best. Water evaporation, especially when imbibition is hot, can be a significant source of error, as can miscellaneous unmeasured water added to the mill with hoses, etc.

Cane weights must be assumed to be correct for commercial reasons, but this may be a dubious assumption. I remember a case in a Louisiana mill (now closed) where the cane was delivered by truck; two brothers drove trucks one behind the other and their mother worked in the scale house; the rear truck had its front wheels on the scale with the front truck; the grinding rate went up but the sucrose in cane went down! This is one of the problems with basing the sucrose in cane on the mill balance. The most satisfactory approach is the independent determination of sucrose in cane, preferably using the disintegrator method, but this is not cheap since it requires significant personnel and equipment if sufficient analyses are to be performed to be statistically significant. The core sampler / press method gives useful relative data on the cane delivered to the mill but the actual values of sucrose in cane depend on too many assumptions.

We have the technology for adequate measurements of juice and bagasse weights so that an acceptable balance (sucrose in cane = sucrose in juice + sucrose in bagasse) can be made,

neglecting the influence of water. The analytical methods required are adequate for the job but must be meticulously performed and their inherent limitations appreciated. My experience is that when these approaches are taken the sucrose percent cane becomes higher than using the mill balance approach. The lesson to be learned is that we must always question the results and avoid becoming too comfortable with the status quo.

In any industry there are sets of well established data that form the basis for operating practices. Thermodynamic (equilibrium) data are generally more solid than kinetic data. We should all be familiar with the solubility vs temperature curve for sucrose in water and with the metastable and labile zones related to the probability of spontaneous crystallization from supersaturated solutions. Supersaturated solutions free of fine suspended solids are expected to have a wider metastable zone than for typical liquors and it would be interesting to determine the supersaturation ranges for liquors than have been prepared from ultrafiltered juices and/or syrups. It is better to think of these factors in terms of kinetic rather than thermodynamic effects. The problem is that our knowledge of crystallization kinetics, especially in technical solutions, is limited and rather inconsistent, varying by orders of magnitude depending on the purity of the mother liquor. Measurements have shown the widest variation in high purity refinery liquors, dropping to less than one tenth the rate at the end of the strike. High crystallization rates at the beginning of the strike may be the consequence of the ease of maintaining high supersaturation by evaporation when the crystal surface area is low at the initiation of a strike in a batch vacuum pan. At the end of the strike the pan may not have the capacity to remove water fast enough to maintain the desired supersaturation and therefore the crystallization rate decreases significantly. The rate thus becomes equipment limited rather than material limited. Data on crystallization rates for low grade strikes are much more consistent, in part due to the relative ease of measurement of slow processes. How many technologists question whether their operations even approach what could be achieved in terms of crystal growth rate?

To achieve the desired output of crystalline sugar a mill requires adequate vacuum pan capacity for this multistage process. My observation in many mills is that crystal yields are significantly lower than could be achieved, the practice being to rush through the process with more crystallization stages than may be necessary. The data on limiting crystal content are derived from the necessity to move the massecuite from the vacuum pan or crystallizer to the centrifugals, hopefully by gravity. Few crystallization operations get close to these limits and this is not considered to be a problem since the final molasses purity is acceptable. Old habits die hard and we need to rethink the process, especially with the new monitoring and control techniques available. More thoughts on this next month.

