

RECENT ADVANCES IN NALCO'S JUICE PURIFICATION SYSTEM

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ABSTRACT

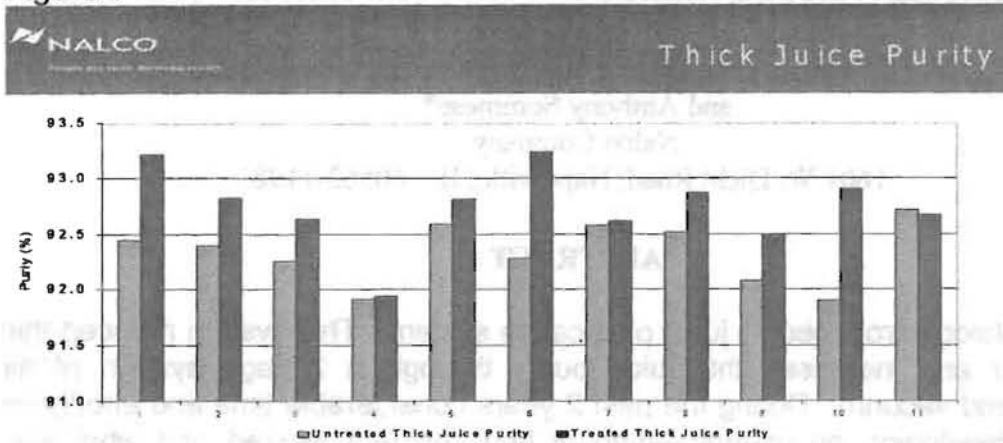
In 2005, Nalco introduced its juice purification system. This system reduced thin juice color and increased thin juice purity through a 2-stage system of air stripping and vacuum. During the past 2 years considerable time and effort was put into developing an understanding of how the unit worked and what was actually being removed. Interestingly to gain a better understanding of the purification system and its effects, there needed to be a focus on carbonation.

To review, as the juice passes through the conditioning system the pH increases due to CO₂ stripping. This in turn, reduces the lime demand in the pre-limer. The stripping action is thought to be responsible for the removal of volatile organics (low MW aldehydes and ketones), which are known participants in color forming reactions such as the Maillard. Interestingly, the purity of the treated juice improved. It was proposed that the unit somehow destabilized the macromolecules and conditioned them toward more efficient removal by carbonation. Early work suggested that proteins were being affected.

This paper tries to answer two questions; 1) Can the purity gain seen in thin juice be transferred to thick juice and 2) Can more information be gleaned to determine the mechanism of purity improvement.

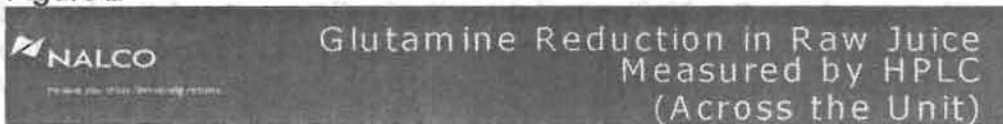
To help answer these questions Nalco built a Pilot Unit. This batch system is a scaled down version of the full-scale units and allows for true paired samples. This unit was shipped to Ostellato, Italy to be run in the CO. Pro. B. Sugar factory. This factory uses an RT diffuser and slices fresh beets. In a series of tests, raw juice was taken from the diffuser and run through the pilot system. Before running a portion was removed and held as the non-treated sample. The juice was then shipped to SAFAS for analysis. SAFAS is an independent laboratory that has the capability to take raw juice and concentrate it to thick juice (45 brix). Paired samples (treated and untreated) were given to SAFAS for analysis. In almost all cases, purity gains from thin juice were passed along to thick juice (Figure 1).

Figure 1



SAFAS has other monitoring capabilities and one of them is the ability to monitor Glutamine. Using HPLC, paired samples (treated and untreated) were tested for glutamine. On average there was a 6% reduction in glutamine when juice is passed through the unit. A further reduction 6% reduction is seen in the thin juice (Figure 2).

Figure 2



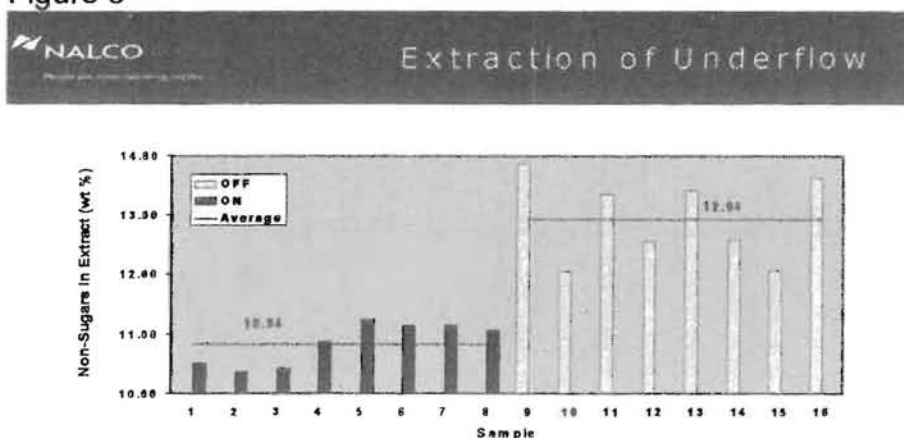
A full-scale installation was put into a Northwestern sugar plant, validation of the unit would be measured by factory changes and Synthetic Thin Juice spot checks. To help see the differences, a 5-day "On" followed by a 5-day "Off" period was agreed upon. Initially promising results were seen, but after only a month of intermediate running, spot purity data deteriorated to zero and the plant was not seeing any downstream effects. After much trouble shooting, the problem was traced back to fouling and clogging of the feed lines and nozzles.

This impedes the juice flow and lessens the shear through the nozzles and was found to be the root cause of the lack of purity. A cleaning protocol was developed. Upon running in a clean unit, purities went back to normal levels. Unfortunately, the season ended at that time. A re-validation was done in December of 2006 and showed a purity enhancement of 0.1-0.2 on high purity beets. The observed purity change did not meet the contractual obligation of a 0.3 average, nor did the plant see any downstream effects. A plan is being developed to address these problems.

Southern Minnesota Beet Sugar Cooperative continues to be the flagship for testing and data generation. Currently, 4 units are in place and running. The work in the 2005-06 campaign focused on carbonation underflow and determining what, if any changes are present when the unit is "On" vs. when the unit is "Off". Carbonation underflow samples were obtained and the sugar washed from them. The samples were then burned at 925°C, to remove any carbon. The organics level was then correlated to a mass loss. Underflow solids contained an average of 1.4% non-sugars adhered lime solids when the unit was off. Underflow solids obtained when the unit was on showed an average organic level of 1.8%. Clearly more was removed when the unit is on and would tend to support the theory that the system conditions the juice for more effective impurity removal by carbonation.

Since a portion of the carbonation solids are returned to the pre-limer to act as a seed, experiments were run to determine how tightly held the non-sugars are to the lime. Extraction of the underflow ("on" and "off") was undertaken using 15% sucrose. More material is adhered to the solids Fig 3.

Figure 3



The Juice conditioning system can best be described as a work-in-progress. Although many positive observations have been seen, our understanding is not yet to the point to be able to "dial in" a desired purity level. Nalco continues to put an effort into understanding the system, because of some of the compelling results seen. To date, we know that purity gains in thin juice transfer to thick

juice. The major mechanism for purity enhancement lies in more effective non-sugar removal in carbonation and the units appear to condition the juice to do this. We have seen changes in glutamine level upon treatment and we know that the unit performance deteriorates when it is fouled. Nalco will continue to deploy the resources necessary to see this innovation through.

Development of 2000 and 2001... The objective of this work was to... a change in the... developed to address these problems.

Southern Minnesota East Sugar... testing and data generation... work in the 2000-01 campaign... determining what... unit is 200... washed from them... The samples were... The rigidity level was... changed an average of... of... level of 1.8%... support the theory that the system... removal by carbonation.

Given a portion of the... need, experiments were... the time... success. More...



The juice... Although many... to the point... left an effort... results...