BENEFITS OF MAINTAINING HIGH PH IN THE WASH WATER WITH CALCIUM HYDROXIDE

Jeffrey L. Carlson
Southern Minnesota Beet Sugar Cooperative, P.O. Box 500,
83550 County Road 21, Renville, MN 56284-0500

ABSTRACT

Maintaining high pH in the wash loop at Southern Minnesota Beet Sugar Cooperative (SMBSC) water controls microbes and aids in the settling of the solids in the wash water clarifier. These two functions have many benefits to washhouse operations including corrosion control, increased extraction, reduced chemical addition to process, improved juice purification performance, improved wash loop clarifier performance, increased alkalinity for wastewater treatment, and reduced environmental compliance costs.

The SMBSC factory at Renville, Minnesota slices from 11,000 to 16,000 short tons per day depending on the time of year and conditions of the beets. It has an extensive wash loop that includes two rotary beet washers, rotary stone and sand catchers, screens and presses for recovery of beet materials with introduction of that material to the factory, a 1.5 million gallon settling clarifier and a pebble lime addition system. The wash loop is operated to maximize the recirculation of the water from the washhouse to the clarifier and back. The clarifier overflow is returned to the washhouse. The underflow, containing the thickened solids, is pumped to decanters that remove 40-65% of the solids, which are trucked out. The suspended solids not removed are pumped to the wastewater ponds in the centrate from the decanter. The solids must settle in the ponds and the water is either added back to the washhouse as makeup water or processed through the wastewater treatment equipment.

The water moves countercurrent to the beets. The makeup water is added at the end of the washing process. The water exits the washhouse just after it has been used to wash incoming beets in the first of the two rotary washers. The water added at the front of the washhouse can be water from the clarifier overflow, condensed waters from the factory or water from the ponds. Since the decanter centrate is pumped to the wastewater pond, there must be a continual makeup of water in addition to that returning from the clarifier overflow.

Over 90% of the water in the wash loop is in the clarifier. By keeping the pH above 11.0 throughout the clarifier microbial activity is reduced and sugar entering the wash water is not converted to organic acids or other nonsugars. It has been found that a pH drop in the clarifier underflow usually the first sign of infection in the wash loop. The solids blanket at the bottom of the thickening clarifier is relatively stagnant and provides a good environment for microbial growth.

Addition of slaked pebble lime ($Ca(OH)_2$) to the incoming water maintains the pH in the washhouse. The water in the washhouse is kept at a lower pH (9-10) to minimize operational problems, which include scaling of screens, pipes and pumps and movement of beets and beet pieces through the equipment.

Several parameters are monitored to ensure adequate lime addition including pH, sugar concentration, total dissolved solids (TDS), total suspended solids (TSS), chemical oxygen demand (COD), process flows, and pebble lime usage. The amount of lime to be added is

determined by monitoring pH values of the water exiting the washhouse. These pH values are determined several times each day.

The clarifier performance is monitored by continuously measuring the influent and underflow flow rates; and daily grabs samples of the influent, overflow and underflow for TSS, TDS and pH. By minimizing the underflow, the maximum recycle is achieved.

The amount of lime necessary to maintain the pH in the wash loop is dependent on a) the quality of the makeup waters and b) the presence or absence of microbial action in the clarifier in combination with the wash loop COD. Hot factory condensate has low TDS and can be brought up to pH 11 with a minimum of lime. The downside of using condensates is that for each gallon of condensate added there is both one gallon of blow down from the wash loop and one gallon of wastewater generated.

Like hot condensate, water from the wastewater pond requires blow down from the wash loop. Unlike condenser water it does not create additional wastewater. However its pH is low and it contains significant nonsugar loading. This can require significant lime addition to neutralize the organic acids and increase the pH to 11. It will reduce the purity of the wash water and contribute to lower purity juice in the factory. Early in campaign when the COD in the ponds is low and the requirement for makeup water is limited, recycling wastewater to the wash loop has minimal impact. Later in campaign, it can have a significant detrimental effect.

If the pH in the clarifier is kept high enough to prevent microbial destruction of the sucrose, the overflow from the clarifier will come to the washhouse with all its acids neutralized and the pH above 11. This water will not require much additional lime to maintain the high pH. If the pH has dropped due to microbial degradation, lime must be added to bring it back up. In addition, extra lime will need to be added to the clarifier influent to increase the pH of the clarifier and reduce the microbial infection. The amount of lime will depend on the total amount of acids being generated, which depends on both the pH and COD of the water in the clarifier.

With an underflow flow rate of 200 gallons per minute (GPM) and the pH maintained at 11, the pebble lime necessary to maintain the system is between three and ten tons per day. If a severe infection is allowed to take hold in the clarifier, it can take several days of adding 30 tons per day to regain control.

The maintenance of high pH with lime aids with settling solids in the wash loop clarifier. Though maintaining high pH is no guarantee that the solids will settle well, several episodes of poor settling corresponding to low pH have been cured by increasing lime addition and reestablishing a high pH. Better settling and thickening in the clarifier allows for a lower underflow flow rate and higher recycle to the wash loop and reduces the wastewater generation.

The fraction of sugar extracted to the wash water from the beets steadily increases throughout campaign. It is lowest with prepile beets (< 1%) and reaches about 2% when washing non-frozen beets in late November. A much greater amount of sugar is extracted when washing frozen beets. Ice crystals in frozen beet tissue have ruptured the cells. Because of this the frozen tissue that thaws during washing exchanges its juice with wash water. The thawed tissue is weak and much of it will abrade away during washing, which further exposes more frozen tissue to the wash water. As much as 12% of frozen beets can be lost when washing.

Some of the wash water is brought into the factory on the washed beets and the beet pieces. By the combination of maintaining the sugar content and purity in the wash water with lime addition and minimizing blow down, much of the sugar can be economically recovered. In early October, by good management, the wash loop sugar concentration can be maintained at 2% with 65 purity. For SMBSC this will increase extraction by 40 CWT per day over not maintaining the pH and letting the purity drop to 30. By January 1, when 25% of the beets being processed are frozen, with good management the sugar can reach 5% at 75 purity. Under these conditions 134 more CWT can be extracted than if the wash loop purity is allowed to drop to 55. When processing 100% frozen beets the sugar content can reach as high as 8% at 85 purity. At SMBSC more than 500 additional CWT can be extracted from beets washed in this water than if the pH is allowed to drop and the purity drops to 65.