pH sensors in sugar refining

Use of Hamilton's Polilyte Plus in raw sugar juice carbonatation

Industry: Sugar production
Application: Carbonatation of raw juice
Hamilton products: Polilyte Plus

Crystalline sugar is the major sweetening agent in many countries. Therefore, a reliable supply of quality sugar is essential for many people.

With an average content of 20%, sugar beets are a major source of the sugar sucrose worldwide. Purification of sucrose from the beets is conducted in refineries through a multi-step process where efficiency is essential to produce quality product with the lowest possible cost.

Freshly harvested beets are cleaned and sliced at the refinery, where the sucrose is extracted by hot water. The resulting raw juice is purified in the carbonatation process, producing thin juice. Through evaporation, thin juice is then concentrated into thick juice and fed into crystallizers to produce the final crystallized sugar product.

Carbonatation and pH

Raw juice contains about 99% of the sugar from the beets, but also several organic and inorganic non-sugar compounds. They can be removed by precipitation with burned lime (calcium oxide) and carbon dioxide.

In the carbonatation process, first burnt lime is added to the raw juice. A loose precipitate of calcium hydroxide and non-sugar compounds forms and carbon dioxide gas is added to the raw juice. The carbon dioxide reacts with calcium hydroxide to produce calcium carbonate (lime), which forms a stable precipitate with non-sugar compounds. The precipitate is removed from the raw juice by filtration, yielding thin juice.

Carbonatation is performed in two steps, both requiring the addition of carbon dioxide that affects the pH value. pH measurement is used to regulate the addition of carbon dioxide in carbonatation.

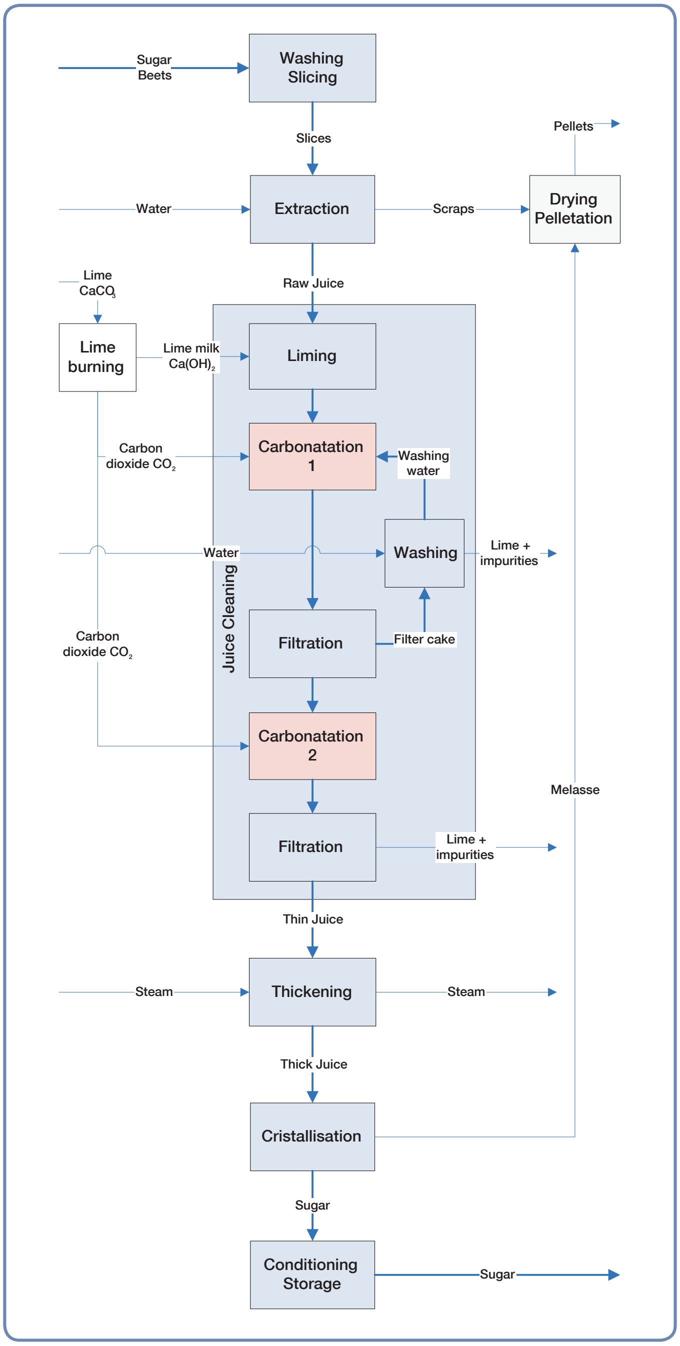

Figure 1: Simplified scheme of the sugar production from sugar beets. This application note focuses on the carbonatation (red).

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In the first step, carbon dioxide is added at a temperature of 90 °C to keep the pH of the raw juice between 11.1 and 11.6. Most of the lime and non-sugar compounds as well as some of the sugar form a precipitate that is removed by filtration. The filter cake is washed to retain the sugar, and the washing water is reintroduced to the first carbonatation step.

In the second carbonatation step, the remaining lime and impurities must be removed. Carbon dioxide is added again at a temperature of 90 to 95 °C to precipitate the remaining calcium hydroxide and remaining impurities. To ensure the correct precipitation, maintaining an optimal pH of 9.1 to 9.2 is critical. If the process pH is too high, the filters will become clogged too quickly. If it is too low, part of the precipitate will be dissolved again.

Figure 2: pH sensor mounted in the second carbonatation

Polilyte Plus in carbonatation

pH measurement in carbonatation is very demanding on sensors because of the high process temperatures (90 to 95 °C, 194 to 203 °F), and solid and sticky compounds contained in the medium.

Sensors are mounted in automated retractable housings so as not to interrupt the ongoing carbonatation. The sensors are cleaned from lime and adherent compounds every 90 minutes with acid, and calibrations are performed between 2 and 3 times per day the ongoing carbonatation.

User benefits of the Polilyte Plus in carbonatation:

- Long durability
- Reliable readings
- Resistant to frequent cleanings
- Slow clogging of the single pore “diaphragm”
- Single pore easily cleaned

Ceramic diaphragms used in standard pH sensors become contaminated and can be extremely hard to clear in these process conditions. Diaphragm contamination leads to bad measurement values and if the contaminations persist, the sensor will become unusable.

Instead of a ceramic diaphragm, the Polilyte Plus sensors have a single pore liquid junction between polymeric electrolyte and medium. This is hard to clog and contributes to the stability of the measurement values. If a contamination should occur, debris can easily be removed from the single pore. In addition, the pH glass of the Polilyte sensors contributes to measurement values with little error in alkaline media.

Performance of Polilyte sensors

At the Pfeifer & Langen sugar factory in Jülich (Germany), the Polilyte Plus showed their strength in carbonatation. Two sensors were in use at each carbonatation tank, one main and one backup. In 2010, the main sensors were in continuous use for at least 8 weeks, some worked flawlessly during the whole production campaign of 3 months.

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