

pH/ORP measurement

Sugar mill carbonation process



Measurement made easy

Sugar refining
sugar mill carbonation
process

Introduction

Milling crushes, shreds or presses the cane or beets to extract the juice to which calcium oxide (milk of lime) is added. The calcium oxide raises the pH of the juice to a little over 11 and the water in the juice reacts with the calcium oxide to form calcium hydroxide. The chemical addition has three desirable effects:

- The high pH prevents the sugar from becoming starch or reverting to non-sucrose forms
- Organic acids are changed into salts for removal by precipitation later in the process
- Foreign matter is retained in suspension for removal by filtration

To prevent scale buildup in subsequent stages, the mill must remove the excess lime via carbonation.

Carbonation

The injection of carbon dioxide (CO₂), called carbonation, usually occurs in multiple stages. Carbonation precipitates the lime as less soluble calcium carbonate (limestone) and takes place by introducing CO₂ gas into the bottom of each tank as shown in Figure 1. Carbonated juice at approximately 11.2 pH and a temperature of 88 °C (190 °F) exits the top of the tank into a collection tank. CO₂ saturation at the carbonation tank exit indicates the end point of the reaction.

During carbonation, the pH must be high enough to remove lime in the form of calcium carbonate (limestone) but if the pH becomes too high in the first carbonation, the calcium complexes with the sucrose, negatively affecting yields.

The carbonated juice and calcium carbonate precipitate travel from the collection tank to a thickener or mud settling tank and allowed to settle, producing two juices, clarified and muddy. The muddy juice is filtered, the filtrate is blended with the clarified juice and the mix is then passed through ceramic filters. The filtrate is heated to between 97 and 99 °C (206.6 and 210.2 °F) then fed into the second carbonation tank. Once the second carbonation is complete (pH = 8.7 to 8.8 at 98 °C [208.4 °F]), the juice goes to a collection tank and is again filtered.

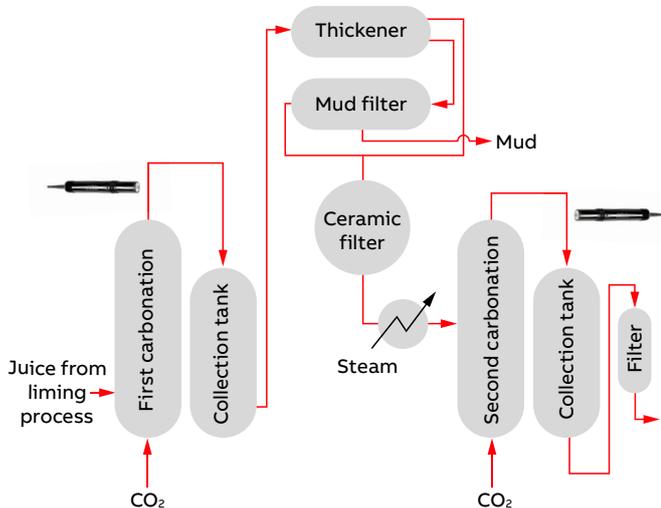


Figure 1 Carbonation process

Challenges in measuring pH

Most sugar mills operate throughout a 3 to 6 month growing season (a 'campaign'), depending on whether beet or cane sugar is the raw material. A pH sensor that can last through an entire campaign is often considered a success.

Sugar refining is a high-temperature, caustic process requiring accurate pH control at almost every stage. Because the process is so hostile to pH sensors, pH measurements had to be made in cooled sample lines (introducing significant lag time) or via grab samples (even longer lag time).

Attempting to control a non-linear variable (such as pH) in a continuous, dynamic process using these methods can easily lead to loss of process control. Prior to improvements in both pH glass and reference technology, on-line measurements were virtually impossible. Excursions of pH regularly occurred and shutdowns were common.

The ABB solution – TBX551 and TBX587 pH sensors

The biggest obstacle in controlling pH in a sugar mill is finding equipment that tolerates the harsh conditions. Lime addition takes place before filtration, introducing precipitation and coating issues. The temperature of the process after pre-carbonation is typically greater than 80 °C (175 °F). Finally, many mills do not have the extensive instrumentation staff that other industries have, so lack expertise on cleaning and calibration of pH sensors.

ABB's Twist Lock TBX551 sensors (see Figure 2) are ideal for sample line installations in sugar refining applications. The bayonet-style mounting facilitates sensor removal for cleaning and calibration. If the pH sensor is to be inserted directly into the process, ABB recommends a retractable sensor with an extraction housing. The extraction housing has flushing ports that can be used to loosen congealed sugar and particulates.



Figure 2 The TBX551 can be mounted in 1 inch tees in sample line installations

The TBX587 (see Figure 3) or TBX557 are good, retractable sensors that are proven to work in these processes.

Sugar mills should specify the coat resistant 'J' Glass electrodes for all carbonation applications. The Wood Next Step Reference are ideal in applications below 11 pH; PTFE is the material of choice above 11 pH. Measurements must not be made on the carbonation tanks because coating becomes a much bigger issue than on flowing pipeline applications.

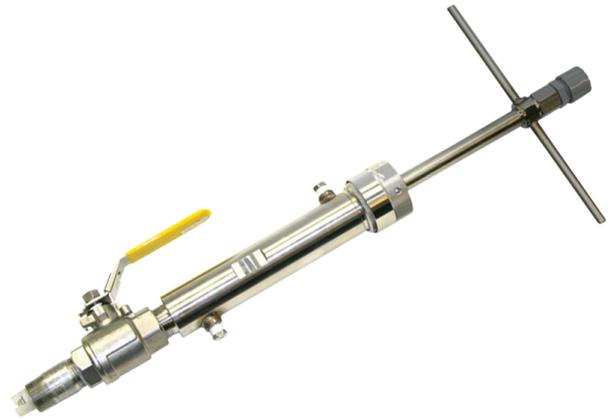


Figure 3 The TBX587 includes an extraction housing with flushing ports

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