

# pH/ORP measurement

## Sugar mill liming process



### Measurement made easy

Sugar refining  
sugar mill liming process

## Introduction

To extract raw sugar juice, the mill first crushes, shreds, or presses the cane or beets. The raw juice is highly pure, but contains undesirable organic and inorganic non-sugar constituents together with color. The mill may add formalin or other antibacterial agents to the recycled press water. The addition of these chemicals work in conjunction with high temperature to inhibit bacterial growth.

The next steps, pre-carbonation and liming, act to purify the raw juice. During purification, insoluble solids, gums, polysaccharides and dissolved colorants coagulate out for removal by settling and filtration. Mills purify the juice using lime and carbonic acid.

To create lime the mill heats limestone (calcium carbonate) in kilns to produce burnt lime (calcium oxide) and carbon dioxide. The end product is mixed with water, becoming milk of lime (whitish lime particles suspended in water). The carbon dioxide introduced to the pre-carbonation tank mixes with water to become carbonic acid.

Cane processors practice partial liming while beet processors apply complete liming. The goal of complete liming is to reduce invert sugar (glucose and fructose) as much as possible by adding an excessive amount of lime. Cane processors partially destroy the invert sugars, using less lime. Some refiners use a combined purification process consisting of phosphoric acid and lime by which 30 to 37 % of the syrup color is removed.

## ...Introduction

The raw juice from extraction is acidic with a pH of about 5.5 – usually controlled by addition of sulfur dioxide. Before entering the pre-carbonation tank, the juice is heated to a temperature between 76 and 82 °C (169 and 180 °F). The addition of milk of lime and carbon dioxide in the pre-carbonation step begins to raise juice pH.

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 later removal by precipitation
- foreign matter is kept in suspension for removal by filtration

On leaving the initial lime tank, the juice pH has been raised to a value near 9. Continued addition of milk of lime in the main liming tank raise the pH to 11 or more. From this point, the juice travels to the first carbonation step to remove excess lime and filter out precipitates.

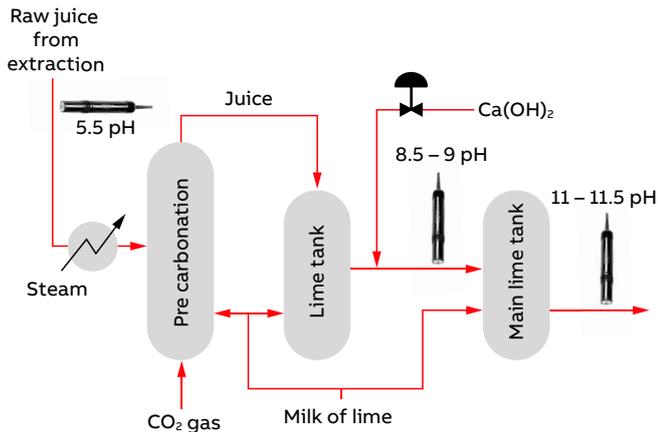


Figure 1 Liming process

## 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 nonlinear 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, online 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.

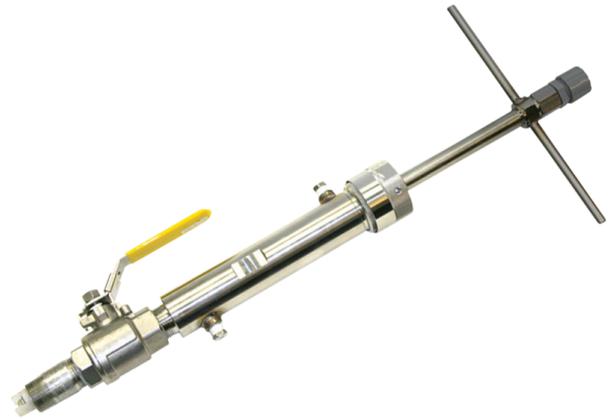


Figure 3 The TBX587 includes an extraction housing with flushing ports

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