Sweet Temptation

Special sensors for measuring the pH value in sugar production

When producing sugar from cane sugar, the pH value plays a crucial role in the quality of the final product. However, the used measurement technology is subjected to extreme stresses in this process. Consequently, JUMO has developed special pH electrodes that are being used successfully in a sugar plant in Ecuador.

The world is not only round, it is also sweet – at least as far as per capita consumption of sugar is concerned. The front-runner is Cuba, with approx. 70 kg per resident a year, followed by Brazil with 64 kg. By contrast, German per capita consumption is "only" 32 kg annually, but this is still the equivalent of 10,000 sugar cubes. While sucrose is extracted primarily from sugar beets in Europe, cane sugar is usually the starting product in South America, Asia, and Africa.

In this process, the harvested sugar cane is cut in the production facility or already when harvested. In most factories the cane is processed in sugar cane mills. This is where the juice is pressed out of the sugar cane. The "bagasse" occurs as residual material. The extracted juice is channeled into settling tanks. This is where suspended solids are removed from the juice through gravity.

After pressing or extraction, cane sugar is brown, sticky, and is referred to as raw sugar. It does not keep well and it has no nutritional advantages over refined sugar. Consequently, sugar must be refined. The refining process essentially consists of two steps: sulfitation and liming. For both of these processes, measuring the pH value is critical for the final quality of the sugar.

Sulfitation (addition of sulfur dioxide) contributes to the white color of the final sugar. Measurement and inspection of the pH value in the running process provides information concerning the quantity of sulfur dioxide that must be added to the juice. For the liming step, hydrated lime is added to the juice to neutralize the pH value. This stops the decomposition of sucrose into glucose as well as fructose and results in precipitation of calcium sulfite, through which impurities are removed.

For the required measurement, the sugar mass has a temperature of up to 100 °C. This high temperature reduces the service life of typical pH electrodes. When cooling, the crystallizing sugar can also adhere to the diaphragm of the electrode. Coatings on the pH sensitive membrane glass can significantly interfere with the pH measurement or even make it impossible.

Since electrode poisons can also still be present in the measurement medium itself, the measurement technology must be extremely durable and reliable. These poisons – in this case the sulfite from the used sulfur dioxide – can reach the conducting element of the electrode through the porous diaphragm and the reference electrolytes. There they destroy the silver / silver chloride reference electrode. This results initially in drifting measured values and ultimately failure of the measuring chain.

Consequently, JUMO has developed a heavy-duty pH and redox combination electrode for extreme implementation conditions. The JUMO tecLine HD pH and the JUMO tecLine HD Rd are particularly robust. They can be used even in difficult processes involving increased pollutants and toxic effects or in oil-containing media at temperatures up to 135 °C and 13 bar pressure.

A newly developed and extensive PTFE ring diaphragm with improved structure enables a quick response time while simultaneously being largely impervious to greater pollution loads or oily/fatty process water and wastewater. The double-chamber architecture is a standard feature. Its extended diffusion path prevents electrode failure in the event of penetrating electrode poisons. A large salt reserve in the reference system enables measurements with long-term stability.

The pH version is also available with an integrated Pt1000 temperature probe. Proven JUMO HT glass is used as the pH-sensitive membrane glass. In addition to greater temperature resistance this glass is also characterized by its high linearity at alkaline pH values (> 12).

Additionally, the sugar producer in Ecuador wanted to compare the online pH value measurement with the pH value measurement in the laboratory at 25 °C for quality purposes. Therefore temperature compensation was necessary for the described process. The measurement signal required for this task is provided by the temperature probe that is integrated in the pH electrode.

Another increase in process reliability was achieved through use of an automatic cleaning system with a pneumatic retractable holder. This enabled the pH electrode to be removed from the process without complication. In addition, crystallized deposits could be cleaned from the pH electrode in the rinsing chamber of the retractable holder outside of the process. The associated control unit includes a cleaning program that has been proven in practical application and which could be easily adapted to the process requirements.

All of these measures not only significantly increase the quality of the final product, they also considerably reduce maintenance efforts due to regular automatic cleaning. It was possible to virtually double the service life of the electrodes as compared to the previously used electrodes.

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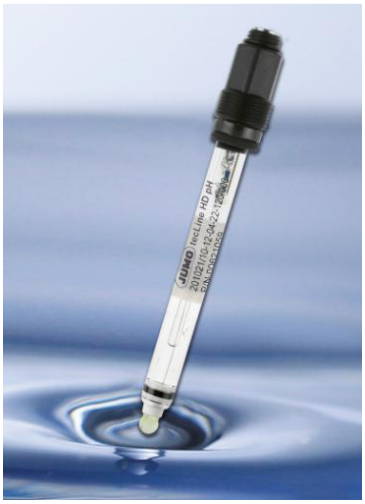

Fig. 1: The new JUMO tecLine HD pH electrode

Fig. 2: The immersion fitting

Fig. 3: The complete system

Fig. 4: Sugar