

Sugar in condensates

application note

Description

Sugar is produced from either cane or beets. (Globally, sugar cane is the predominant source.) Processing must begin immediately after harvest to avoid rapid deterioration. During processing, large quantities of steam are required to extract, purify and concentrate the sugar prior to final crystallization.

Raw sugar is extracted as sucrose ($C_{12}H_{22}O_{11}$). During extraction, sucrose yields equimolar amounts of glucose and fructose in an “inverted solution”. Although glucose and fructose have different structures, they share the same molecular formula ($C_6H_{12}O_6$).

In a sugar mill, the fuel used to produce steam is a major operating cost. Fuel oil may be used, or the wooden residue from the sugar plant (bagasse) may be burned as fuel. Because bagasse is used to make other products, it is economically essential to maximize the efficiency of bagasse combustion. This can be achieved through closed-circuit condensate reuse. This saves energy, thereby reducing fuel and water preparation costs.

Sugar mills used to operate with low pressure boilers (up to 15 bar). Many of these older plants have either disappeared or have upgraded to higher pressure (> 40 bar, sometimes higher in large refineries). As in power generation, the quality of the feed water re-

quired is directly related to the pressure. One of the main concerns for a boiler operating as a closed circuit is the risk of returning contaminated condensate to the boiler feed water tank. At several places in the process, the steam and hot water circuits are at a lower pressure than the light sugar or syrup solutions. This introduces the risk of sugar entering the circuit. This possibility emphasizes the need for condensate monitoring to avoid pollution of the drum and subsequent major damage to the boiler.

Today, most sugar factories, especially in Europe, employ dual production cycles. Syrup is produced in the autumn, followed by a second treatment of the syrup in the spring to produce purified sugar. This process has been used since the middle 1980s, producing a very high quality product with very low levels of impurities.

Previous monitoring solutions

Over the years, sugar factories have installed various devices to detect impurities in the sugar: conductivity monitoring, flame photometry analyzers, and even sodium analyzers. These measures may be applicable to raw sugar processing where there are many impurities, or their effectiveness may be limited to old-style mills using low-pressure boilers. In either case, they have had limited success.

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- Conductivity has succeeded in detecting heavy pollution from raw sugar solutions. However, the impurities are often in the form of salts. The salt concentration is often insufficient for reliable measurement, unless a second cycle of the condensate is employed. The resultant decomposition of sugar raises conductivity, but it may be too late in the process to counteract the damage raw sugar solutions can cause.
- Sodium measurement, either by ion selective electrodes or by flame photometry, has also been tried (low levels of sodium are present in sugar). The detection limit is a few ppb, and the measurement is subject to ambient sodium in the water. Potassium measurement has proven unreliable for continuous use.
- Photo-colorimetric analyzers have been tested to selectively measure sugar content, but this technique has never proven reliable enough for on-line use.

Zellweger Analytics solution

The following considerations make TOC analysis the only reliable method for detecting sugar in recycled water.

- The economics of alternate energy sources and cogeneration demand strict accountability for the choice of fuel source(s).
- High-pressure boilers have increased the consequences of impurities in boiler feedwater.
- Previously tried detection methods are either obsolete or ineffective.

The presence of 10 ppm of sugar in the boiler feed water is recognized to be the limit. With the ratio of molecular weight to carbon content, this limit of 10 ppm means a TOC value of 4.2 mg C for sucrose or 4.0 mg C for either glucose or fructose. Our autoTOC 1950plus analyzer in the range 0 to 5 ppm or 0 to 10 ppm is ideal for this application and available in 115 or 230 VAC versions.

If any of the condensate return lines are exposed to a risk of significant pollution from a non-sugar source (a preheating heavy fuel oil circuit, for example), they should be isolated from the other contamination sources. This will ensure that the presence of TOC can be confidently interpreted as sugar and not something else.

Purge gas: CO₂-free oxygen or nitrogen, 1 l/m maximum, 2 bars (58 psi). If purge gas is not available, use Zellweger Analytics' AAS300 purge gas generator.

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