To meet production and profit goals, food and beverage operators are challenged to find ways to improve their manufacturing processes. Staying competitive also means ensuring plants comply with regulations, wastewater treatment processes are optimized, and assets — such as boilers, heat exchangers, treatment equipment and product tanks — are safe. Success in the food and beverage industry depends on quality control and maintaining a high-quality product and positive brand image.

Total organic carbon (TOC) analysis offers a simple method to measure water quality and provide insights into all organics present — from ingredient to production to wastewater processes. Tracking organic load variations in real-time provides food and beverage manufacturers with a data-driven decision-making tool for quality control, process monitoring and regulatory compliance.

By instantly detecting leaks, food and beverage plants can make fast adjustments to help prevent contamination, minimization the risk that product does not meet quality specifications, which would otherwise require manufacturers to discard product and take a financial loss. Undetected leaks can lead to product recalls, which greatly impact brand image. Detecting leaks in real-time is also critical for protecting assets from organic contamination and avoiding damage, downtime or catastrophic issues that could result in millions of dollars in costs.

Since food and beverage products are organic in nature or have organic components such as flavors and dyes, TOC analysis is highly effective for determining the cleanliness of equipment, thus ensuring product quality and safety. Moreover, as a proactive-based solution, TOC analysis can provide key insights for increasing wastewater process efficiency to deliver long-term cost savings and guarantee that treated effluent meets certain water quality criteria.

The following examples highlight different ways in which TOC analysis can benefit food and beverage operations.

**Bottling company optimizes MBR wastewater treatment process**

Due to increased production, the wastewater treatment system at a major bottling company could not keep pace with the resulting larger volumes of high-strength organics and solids content. Consistent operation was
complicated by highly variable influent, including major fluctuations in sugar loading and plant flow. As a result, chemical oxygen demand (COD) removal per local regulations was hindered, and the plant often released discharges that exceeded permit limits. The plant’s manual method of COD testing required more than three hours to generate results and the values were insufficient to allow for process adjustments.

With plant expansion not feasible due to a lack of space and high fluctuation from the production facility, modifications were made to divert concentrated organic and high COD waste for storage. This allowed concentrated waste to be slowly metered back into the process during periods of low concentration flow. The bottling facility also decided to add a membrane bioreactor (MBR) wastewater treatment system due to the small footprint of the unit.

To maintain healthy biomass, a 100:5:1 carbon/nitrogen/phosphorus ratio is required for the bottler’s application. With carbon having the highest variability and the largest concentration, the bottler elected to use TOC analysis to continuously monitor the organic carbon load. An ammonia product was added as needed to the equalization basin to maintain the nutrient balance ratio. Here, TOC analysis — programmed to output load data as a correlated COD value — was used for the process control input to dose ammonia as COD varies. Once stabilized, the MBR system benefited the facility by drastically reducing effluent total suspended solids (TSS) and greatly improving COD removal. The combined solution saved the bottler hundreds of thousands of dollars annually on costly chemicals, waste-hauling fees and fines.

Sugar mill prevents costly product leaks
A prominent Colombian sugar mill processes roughly 4,300 tons of sugarcane per day for domestic and global customers. Given its production capacity, it was crucial to optimize production and prevent any leaks of valuable product into process streams.

Processing sugarcane into sellable goods involves a series of steps that includes grinding, clarification, filtration, evaporation, crystallization and centrifugation. Evaporation involves a multistage distillation system to concentrate sugar juice. The first stage is fed with a clean steam source from a boiler, and the resulting evaporate feeds the next stage, continuing through all steps. The steam from the final stage is condensed using a barometric condenser and is collected in a cooling tank. Condensed water from each stage is collected and added to the cooling tank for later use as cooling water.

To protect equipment assets and mitigate risks of product and profit loss, it is critical that condensed water is free of any sugar or sugar juice, making effective monitoring for leaks or upsets of high importance. Early detection of a product leak can help the mill stop, divert or improve a unit operation before damage or costs are incurred.

The mill previously used pH, conductivity, alkalinity, brix degrees and high-performance liquid chromatography (HPLC) analysis to determine product leaks. However, since sugar is nonionic with a neutral pH at ambient conditions, most of those methods are not suitable for leak detection. Moreover, during production at elevated pressures and temperatures, sugar begins to decompose into harmful compounds that may cause equipment deposition, corrosion and scaling. When sugar decomposes, it also loses its HPLC signature peak. Based on these factors, a rapid and accurate method to measure sugar concentrations was needed.

As a carbohydrate composed of carbon, oxygen and hydrogen, sugar is easily detected with the sum parameter measurement of TOC, which accurately quantifies all organic compounds in a solution. The mill invested in TOC analysis to characterize and profile its system, allowing the establishment of control limits for steam, condensate and cooling water, which helps optimize production and maximize profitability.

The evaporation stages of the milling process, which involve the repetitive heating and cooling of consecutive steam and condensate, are key points for the mill to monitor for sugar leaks. By using TOC monitoring at these critical steps, the mill could achieve profit goals and maintain both environmental and operational objectives.

Food and beverage company improves cleaning cycle efficiency and quality control
A California food and beverage company that manufactures over 350 individual products annually sought to implement new process tools to improve product quality and safety. Although ATP swab tests were used to check for microbial contamination, the company still experienced recurring quality issues and product loss.

To improve quality control of its cleaning process, the company used TOC analysis to monitor rinse samples after clean-in-place (CIP) cycles prior to sterilization to verify the cleanliness of its manufacturing equipment, ensuring that time is not wasted attempting to sterilize dirty equipment. While there are techniques available to test for microbial contamination on equipment (such as ATP swabs), these tests lack the necessary accuracy and selectivity for residual soils and are prone to false positives.

After implementing TOC analysis, the company tested it against the ATP swab test. Passing ATP swab test results indicated a piece of equipment was free from microbial contamination following the CIP cycle. However, TOC analysis showed the same piece of equipment had organic residues (which was also confirmed by operators performing a visual inspection). Prior to TOC analysis, the company would have used ATP data to confirm cleanliness and proceed to sterilization, which would have led to manufacturing subsequent batches of product with dirty equipment, resulting in unacceptable product quality.
Another area of application is confirming equipment cleanliness following idle time. The California facility estimated that it would save more than $10,000 per month in water, labor and chemical costs by reducing the number of times workers cleaned equipment that sat idle for longer than the allotted hold time.

At the California facility, up to 50 batches of product are run in 36-hour production sessions. Any issue during a session that causes product loss costs a minimum of $200,000. Since TOC analysis is more accurate than other tools for determining equipment cleanliness prior to sterilization, the facility can now minimize the risk of financial loss and product recall.

With the company also looking to reduce water usage in its manufacturing, TOC analysis can help optimize CIP cycles and potentially confirm that a shortened cleaning cycle is adequate for removing all soils from equipment. Shortening CIP cycles — even if only by several seconds — can result in significant cost savings over time from reduced water usage. The company also planned to use TOC analysis with rinse samples to troubleshoot production equipment throughout the production and cleaning process and locate points for possible optimization.

**Conclusion**

By employing real-time organics monitoring with TOC analysis, plant supervisors can better understand their carbon loading to ensure water quality is continually optimal and free of organic contamination. The ability to quickly identify problems and take immediate corrective action before damages are incurred enables food and beverage manufacturers to meet product quality demands and avoid impacts to both brand integrity and the bottom line.

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